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High-Speed Concreting Marks New York Highway Job

More than two thousand feet of eight-inch pavement ten feet wide laid in a day, with a season's average of over eighteen hundred feet, with a 27E paver. Abundant equipment and clock-like operation

By Harold O. Weyrauch

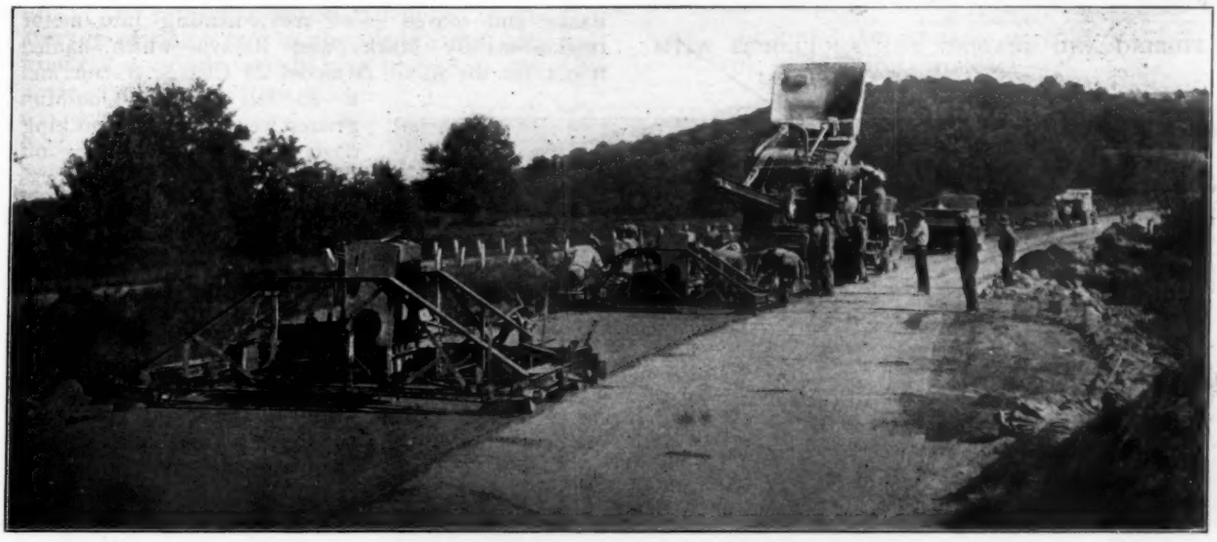
Through excellent management and the use of well-chosen modern equipment, what is claimed to be a world record has been achieved in the placing of concrete on a road between Monticello and Liberty, N. Y. In addition to the job record, a very high daily footage of pavement has been placed. At the time the job was visited, late in August, a day's run of 2095 feet of 8-inch concrete pavement, 10 feet wide, was the maximum, with a second-best run of 2041 feet; but the contractor says that he hopes to lay 2250 feet in ten hours before he finishes the contract—which would require almost perfect synchronizing of the entire outfit.

The average of the daily runs is well over 1800 feet. Concreting was started August 3, when a few hundred feet were placed; on August 5, concrete placing really began, and, favored with good working weather, a very high daily production has been maintained. At the close of work on August 29, 3¼ miles of two-lane and 2⅛ miles of one-lane road had been laid, an average very close to 2000 feet per working day.

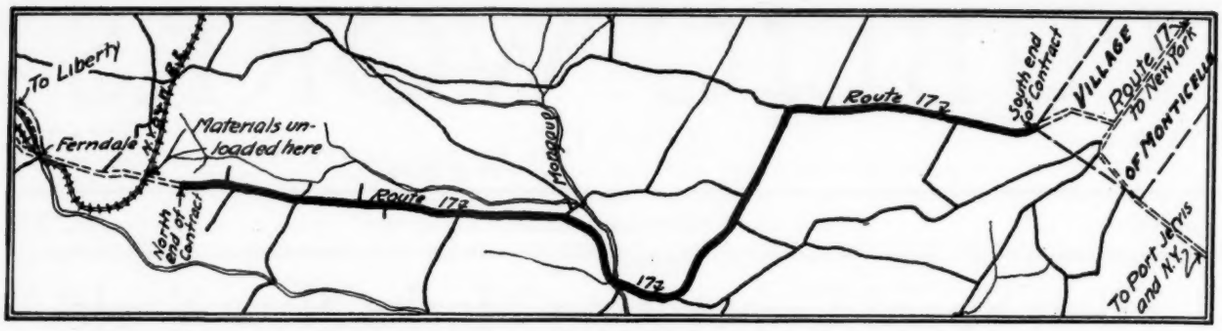
The contractor is John Arborio of Poughkeepsie, N. Y., and the superintendent in charge of the work is J. F. Ableman, of Norwich, Conn., now living in Monticello. The section under construction consists of 7.5 miles of Route 17, the Liberty Highway, between Monticello and Liberty, in the lower Catskill section of New York State. (The work on another section of Route 17, lying just north of Liberty, was described in the September issue of PUBLIC WORKS.)

The old road, of bituminous macadam, was still in fairly good condition after nearly twenty years of service under a volume of traffic which has been steadily increasing for years and now is exceedingly heavy, especially during the summer months. Lack of width, and curves not designed for heavy traffic at high speed, were factors in the decision to rebuild the road; as were also the maintenance costs, which, under the present heavy traffic, have become quite high.

The new road is of the New York State standard type, mesh-reinforced concrete, 8 inches thick, and built in two lanes each 10 feet wide. Grading and



MIXER AND FINISHING MACHINES ON MONTICELLO-LIBERTY ROAD



MAP SHOWING LOCATION OF CONTRACT WORK ON ROUTE NO. 17

AGGREGATE BIN AT STRONGTOWN CROSSING

FILLING AND GRADING THE SHOULDERS WITH AN ERIE SHOVEL

BARNES TRIPLEX PUMP SUPPLYING WATER FOR CONCRETE ROAD

location are designed to allow the construction of another 10-foot lane when it shall be required by increased traffic. Shoulders are 4 feet wide in cuts and on the level, and 5 feet on fills. The work involves about 60,000 cubic yards of unclassified excavation, the placing of numerous culverts, and the building of three concrete bridges, the largest with a span of 42 feet.

The excavation is mainly in the relocation work, being required in the elimination of curves and the cutting down of grades. Most of this work included some rock excavation, as in this section of the Catskills rock is never far below the surface. There were no heavy fills, the deepest one being less than 12 feet. These fills were placed first to allow for settlement, but it was not considered necessary to allow the shallow fills to settle prior to paving them.

The contract price for the job amounted to $387,000. Two hundred working days are allowed for completion. Grading and relocation work began on May 28th, 1929, but the placing of concrete did not start until August 3. The contractor expects to have the contract fully completed by November 15, 1929.

GRADING

A considerable amount of heavy machinery was used to advantage in the grading work. This included one Type B Bucyrus-Erie steam shovel with ¾-yard bucket; one model 700 P & H excavator with a 1¼-yard bucket; and one Model 105 Northwest shovel with ¾-yard bucket. These cut down the banks and moved loose rock, loading into motor trucks—mainly Macks and Relays—which hauled it out for the fills. A model 20 Cletrac tractor and a Riddell Warco One-Man grader were used for knocking down the fills and leveling off the grade. Where rock was encountered, Ingersoll-Rand air compressors and drill equipment were used, and the rock blown with du Pont dynamite. The blasted rock was handled by the shovels and loaded into the trucks for fills. The shovels also did some good work in handling loose large boulders, which occurred frequently along the road.

During June and July, attention was concentrated mainly on the grading work and the

entire section was brought into shape for concreting. Traffic was heavy during these months because of summer visitors, this road being in the heart of the resort section, but there was little interference with the traffic except that the road was very dusty.

Fine Grading:—A fine grading gang consisting of a foreman and 7 men managed to keep ahead of the concreting gang, despite the high daily average of work. A light truck and an Acme 12-ton gasoline driven roller and an H. P. One-Man grader was about the only equipment. A Fordson-type 5-ton roller operated just ahead of the mixer, keeping the subgrade in shape for concreting.

CONCRETING

Forms:—Heltzel forms were used on the job. These were placed by a gang consisting of a foreman and 6 men, who kept about a half mile ahead of the mixer. As soon as the forms could be removed, they were stripped by a special gang and carried ahead in a light truck for re-use.

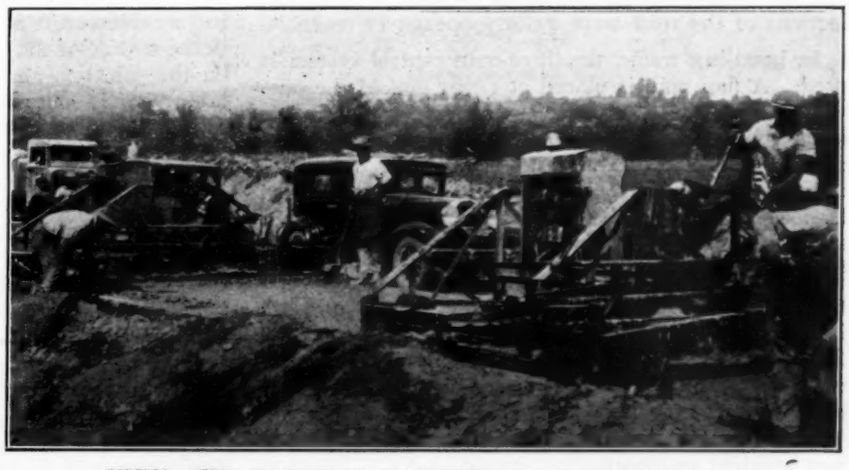
Materials:—Aggregate is shipped to a siding located near Strongtown, about a mile north of the north end of the job. Track room is provided here for 19 cars. These are unloaded into pits 14 feet square and 10 feet deep, from which the materials are removed by a Northwest crane and stored in convenient stockpiles. As needed, they are loaded by the crane into a Johnson batching bin located near the siding. From the bin, the material is hauled to the job in motor trucks equipped with two-batch bodies. International, Relay, Federal, Mack and Maccar trucks are used on this work. These are run ahead of the mixer and backed up to discharge into the scoop. As the mixer worked away from the loading station, the problem of turning the loaded trucks did not present itself.

Laying the Pavement:—A Ransome 27E paver is used. The mixing gang consists of 4 spaders, 3 finishers, and 2 joint and reinforcement men, in addition to the mixer operator. The mix is 1:2:3½. Nazareth quick-setting cement is used in order to facilitate opening the road to traffic. Every effort is made to keep the mixer operating for a maximum amount of time, and the scheduling of trucks carrying aggregate is arranged so as to avoid loss of mixer time. The result of this careful operation is reflected in the high average of daily runs made, despite the long haul from the stock pile. At the time the record runs were made, the haul to the mixer was some 4 or 5 miles. Exceedingly good management was required to maintain a high rate of mixer operation, despite delays due to traffic and other causes.

The contractor endeavors to "keep at least one truck always ready to dump a batch of aggregate into the hopper and thus keep the mixer going practically every second of the working day."

Curing and Finishing:—Two Lakewood finishing machines are employed behind the mixer, with a total of 3 men in addition to the machine operators. Curing is with hay, which is purchased locally, and the pavement is opened to traffic 7 days after laying.

DUMPING AGGREGATE INTO SKIP
CHARGING MIXER DRUM
DUMPING CONCRETE ON ROAD



USING TWO FINISHING MACHINES ON THE CONCRETE

Water Supply:—Water for the various operations of the contract, and for the machinery, is pumped from brooks along the way. The supply line consists of 4½ miles of 2-inch pipe, with hose outlets 300 feet apart. The pumping units consist of one C H & E pump, and a Barnes triplex powered with a Hercules engine. This latter pumped from Mongaup brook, the low point on the road, and handled water through nearly four miles of line, with a gauge pressure showing around 500 pounds all the time. There were no storage tanks, but a by-pass relief valve was provided. Other pumps on the job included a W. & B. Douglas triplex pump, chain driven from a 4-cylinder motor and truck-mounted and a Domestic centrifugal pumping unit.

OTHER CONSTRUCTION FEATURES

Culverts and Bridges:—The three concrete bridges included in the contract are of 12, 22, and 42-foot span respectively. The first two are slab bridges, and the last, which crosses the Mongaup near Harris, is a T-span. Cast-iron culverts are used. The trenching for culverts and the placing of the pipes was done economically with a gasoline-driven Universal truck crane. Small concrete mixers on bridge and culvert work included a Jaeger, a Koehring Dandie, and a Ransome.

Shoulders:—Finishing of shoulders to approximate grade and shape was done with the Bucyrus-Erie shovel. A truck was used for conveying spoil and fill material.

Equipment and Labor:—An unusually large amount of equipment was employed on this job. In addition to the three shovels and a crane, already mentioned, the tractor, the grader, and the rollers, motor trucks of various sizes and makes reaching a maximum number of 34 were employed on hauling spoil and handling aggregate to the mixer. About 75 laborers are engaged on the job. These are all imported, and are maintained in a camp suitably located.

Traffic Control:—The arrangement of the work was such as to minimize the traffic troubles of both traveler and contractor during the initial stages. After concrete placing began, as one-way traffic had to be maintained, there were delays; but considering the exceedingly heavy traffic, the interference has been slight. A factor in this was the short curing period, which limited the amount of road that had to be kept closed, and the expeditious placing of the concrete so that long sections of the road were quickly opened to travel.

In handling traffic, the three-man control system is used. A flag man is placed at either end of the one-way section, and a third man drives through in his own car in the rear of the convoy. He is thus available to take care of traffic jams and other difficulties due to mechanical troubles of cars, and those caused by local traffic which turns into the road between the flags, often in opposition to the direction of travel.

Personnel:—In addition to J. F. Ableman, superintendent, credit for the high average amount of work is due to J. M. Adelizzi, general manager for John Arborio, and Dan Rodriguez, who is in charge of concrete operations. The work was under the supervision of Roy Barton, county assistant engineer for the New York State Division of Highways, and J. P. Keene was resident engineer.

Arcading as Traffic Aid in Los Angeles

A new state law in California permits condemnation proceedings by municipalities for taking and arcading the fronts of the lower floors of buildings for sidewalks or pedestrian traffic purposes, the object being to permit cities to increase the traffic capacity of streets without materially decreasing the value of the abutting commercial structures or involving the city in enormous expenditures for the purchase of properties. It is reported that Los Angeles is expected to take advantage of that law in the near future, the work contemplated being along a section of Second street and other streets in the business section. It is proposed to move back the building front for a height of two stories, for a distance sufficient to provide sidewalk space. It is believed that setting back two stories will prevent objectionable darkening of the store front in the set-back section.

Doubling a Road Plant's Output

Mayer Brothers, of Erie, Pa., had a contract for laying a Topeka pavement in the western part of New York State. There were 11 miles to be built and the work was not progressing as rapidly as the State Department of Public Works wished. Accordingly the district engineer, Charles R. Waters, urged them to duplicate their asphalt plant so as to hasten the construction. They countered with the request that they be permitted to work a second shift at night, using the same plant. After considering the matter, this request was granted provided the work proved satisfactory. As it progressed it was found better to have the night shift lay the binder course, and the day shift lay the top course. The difficulty at first was to obtain sufficient lights and to place them so as to minimize the high lights and shadows. After this feature had been adjusted, no serious troubles were encountered. Aside from completing the pavement on time, there was another advantage, according to Mr. Waters in a paper by him before the Associated General Contractors of America. This advantage was that, by operating the plant continuously, the maximum efficiency was obtained, as the heat of the plant was not allowed to die down.

Another illustration of double shift was given by Mr. Waters, that of a contract by McKibbin and Rockwell, in which Mr. McChesney, in charge of the work, started the fine grading gang at sunrise and had a second shift report about noon. For a few hours in the middle of the day there were two grading gangs on the job, one ahead of the other. This contractor laid from 1300 to 1500 lineal feet of pavement per day and the double gang insured no delay from lack of fine grade. Several contractors in that section of New York State have tried laying concrete pavement at night, but they have all had trouble with various operating features and soon discontinued it.

Mr. Waters stated that he was inclined to think that, even though some experiences to date with night work have not been very satisfactory, considering that there are only 120 to 150 available good working days in the year, night operations may become more common in the future than they have been in the past, especially if the size of contracts continues to increase.

Another solution of this matter of brief working time suggested by Mr. Waters is that contractors lose

less time getting started after they receive their contracts. This loss usually occurs during the best working season, and they endeavor to make up for it by speeding up in the fall, when frost is beginning to occur.

"As I see it," said Mr. Waters, "the difference between the successful and the unsuccessful contractor, other things being equal, is largely one of method, organization and attention to details. If one wishes to move his earthwork only once, or to get 36 to 40 barrels of concrete through the paver per hour, 360 to 400 batches per ten-hour day, he needs to have a high-class working organization, and he also needs to push on the reins. Otherwise he will lose money or waste time—probably both, and as a consequence his final figures will be seriously affected."

Granulated Slag Under Pavements on Clay Subsoils

For the past three or four years, the city of Cleveland, Ohio, has been using granulated slag cushion under concrete bases and pavements over clay soils. This practice was explained by George B. Sowers, deputy commissioner of the Division of Engineering and Construction of that city, before the National Paving Brick Manufacturers' Association at its twenty-third annual meeting. Mr. Sowers stated that the freezing and thawing, the drying out and wetting of the clay under a pavement has much to do with whether the pavement gives satisfactory service or goes to pieces. Though the final breaking up of the pavement may be due to load failures, the initial trouble is due to the subgrade conditions. Instead of building thicker and stronger pavement bases in an effort to carry the increasing traffic loads over more or less unstable subgrades, it is more logical and economical to increase the supporting power of the subgrade.

The subgrades in Cleveland range from almost perfect sand to clays which heave and lose practically all their supporting power during portions of the year. For the past three years the city has been increasing the supporting power of clay subgrades by using a four-inch cushion blanket course of granulated slag with ample drains below the slag. This has largely overcome the cracking of pavements and especially longitudinal cracking. The granulated slag used is produced by pouring molten blast-furnace slag into water and considerable quantities are available in those sections of the country where iron is produced. About eight inches of loose slag is placed over the concrete, which, when tamped and rolled and thoroughly compacted, reduces to about a four-inch thickness, with a very hard surface.

The granulated slag cushion "is not to be confused with the gravel or crushed stone sub-bases used in some places. It provides insulation and, being a porous material, prevents frost going down into the subgrade. It intercepts the capillary water that comes up through the clay, and when the sub-base is well drained, the accumulated water has a chance to get away before it forms ice; or if it does form ice which later melts, the porous sub-base permits the water to drain into sewers instead of softening the subgrade.

"The slag cushion also furnishes an additional strength of base for distributing the traffic loads. It has a tendency to form a material something like a lean concrete which has, I think, considerable advantage for distributing the load. It also makes a smooth surface to lay the concrete on, so that you get a more uniform thickness of concrete in the pavement or base.

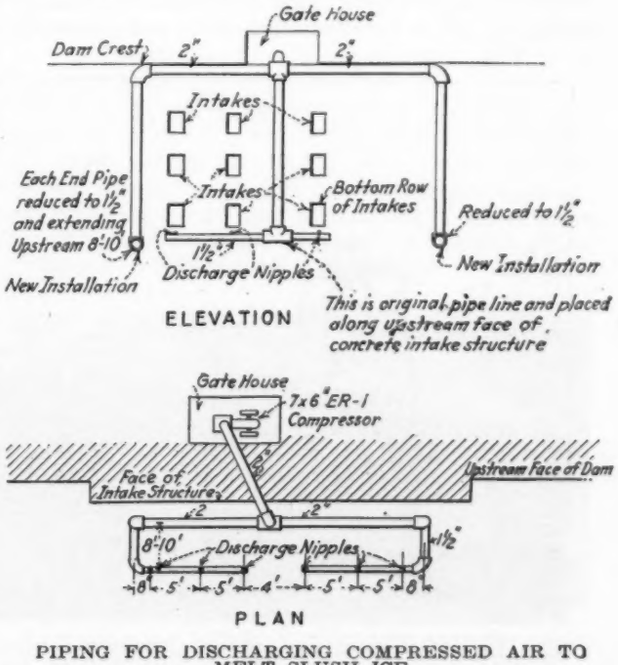
"The cost of the 4-inch layer of granulated slag, in place, is equivalent to approximately 1½ inches of foundation concrete. I believe that the four-inch cushion blanket course is worth more in the pavement than 1½ inches of additional concrete would be."

Commenting upon this, Professor F. H. Eno, of the Highway Research Council, said: "I agree with Mr. Sowers exactly that sub-bases are very important, and above all I believe granulated slag is the best material for them which I have found. Cinder is good and crushed stone will do, but I believe granulated slag is the best sub-base material there is."

Slush Ice In Seattle Water Supply

Use of compressed air prevents stoppage of intake openings in reservoir

The city of Seattle, Washington, obtains its water supply from Cedar river, which has a watershed in the Cascade mountains of about 137 square miles above the headworks. As little rainfall occurs from June to September, the matter of storage to tide over the dry season is a very important one. To provide this storage, the city has built a dam about 40 miles from the city, the overflow of which is at elevation 1546. From here to the intake, 12 miles distant, the river falls to elevation 536; and this fall of over 1000 feet is utilized as hydraulic power for the municipal lighting plant and for general power purposes. Water is drawn from the storage reservoir, known as Cedar lake, through a gate house provided with openings at three different elevations 17 feet apart, there being three openings at each elevation, the lowest of the



PIPING FOR DISCHARGING COMPRESSED AIR TO MELT SLUSH ICE

openings being at elevation 1500. These openings all connect with an 11-foot tunnel which carries the water to penstocks of wood-stave and of steel, which carry it to the power house. Above this dam, which is of concrete, is a crib dam 7920 feet further up stream, where gates and intakes admit water to the basin between the two dams.

In December, 1924, slush ice accumulated under the surface ice which had formed in the basin between the dams. This slush ice extended from the surface ice all the way down to the lowest gate opening and obstructed the intake. When the penstock gates were opened at the power house, a vacuum was created sufficient to cause a deformation of the pipe, and as some of the pipe was wood-stave, this was collapsed by the vacuum and some of the staves were carried down to the power house. Divers were used in the reservoir in connection with the repairs, and J. L. McCartney, foreman of the headworks, noticed that the air rising from the divers' helmets melted the surface ice and kept a circular area clear; and this suggested to him the advisability of using compressed air for preventing the trouble from slush ice. He obtained a 7x6-inch portable air compressor, capable of furnishing 100 cubic feet of air per minute, which was subsequently augmented by a stationary compressor driven by a 15 h.p. oil engine, providing air at a pressure of 95 pounds per square inch. The compressor was placed in the gate house and delivered air through a two-inch pipe which was carried to and down the face of the intake structure, to a point below the lowest intake, where it was reduced 1½ inch pipe set horizontal and provided with discharge outlets which were fitted with check valves to prevent flooding the pipe when the air was turned off. At first, quarter-inch outlet openings were tried, but as they discharged larger volumes of air than seemed necessary, ⅛-inch nipples were used, which proved sufficiently large to discharge an effective volume of air without overtaxing the capacity of the compressors. Later, instead of having the discharge occur immediately in front of the intake structure, the horizontal pipe carrying the discharge outlets was offset 8 or 10 feet, as shown in the drawing.

There was no more trouble with slush ice that winter, and not until the winter of 1927-28 was it necessary to use the compressed air outfit. On one occasion during that season, ice about four inches thick formed just above the dam and the compressed air apparatus was utilized for thawing it. The air was released during a single night and thawed the ice for a radius of about 10 feet in front of the intakes. During the winter of 1928-29, which was a rather severe one in that section of the United States, ice formed above the dam to a thickness of about 10 inches, but by using the 7x6-inch compressor, Mr. McCartney was able to keep the intakes clear.

The screens also have been changed. Before the compressed air equipment was installed, each of the intake openings was covered with a one-inch mesh screen. Afterward, these screens were supplemented by a single box screen which covered all the openings, being supported by a rectangular frame and extending three feet up stream from the face of the intake structure.

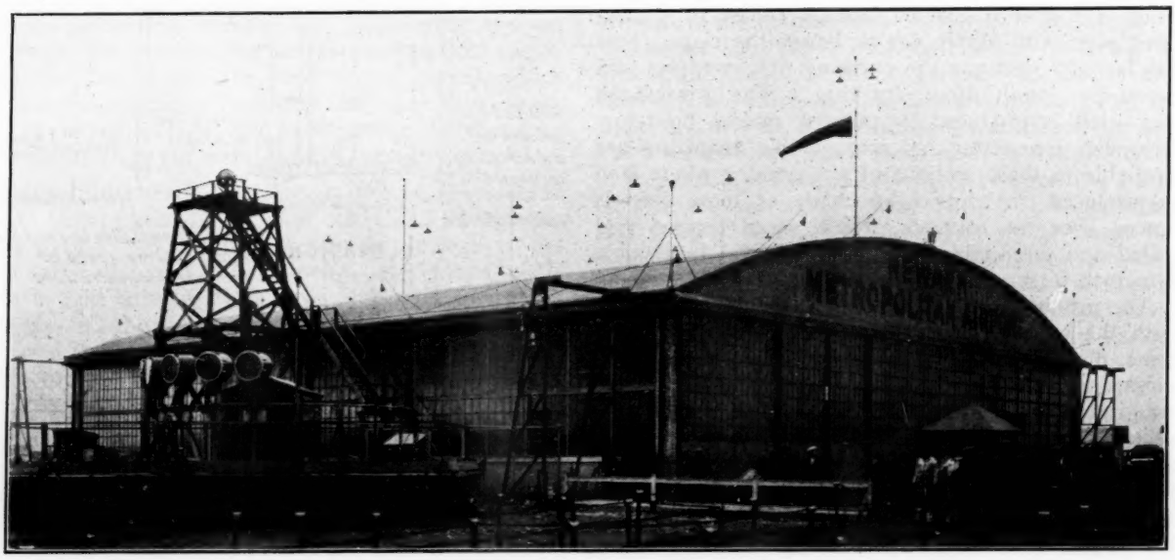
Airport Lighting

Requirements of U. S. Department of Commerce for receiving an "A" rating. Newark airport as an example

The requirements of air service include provision for travel by night as well as by day, and the lighting of airports to make night use of them practicable is therefore a very important feature of airport construction.

In order to receive an "A" rating by the U. S. Department of Commerce, the following lighting equipment is required:

1. Airport Beacon—The requirements of a satisfactory beacon light are adequate candlepower, not less than 100,000 for long range; proper distribution of light in the vertical plane to make the beacon visible all around the horizon and to the zenith, or nearly so, for altitudes of 500 to 2,000 feet; distinctiveness for identification; luminous periods of not less than 10 per cent; and eclipse periods of not more than 10 seconds duration.



HANGAR AT NEWARK AIRPORT, SHOWING HANGAR LIGHTING INSTALLATION, AIRWAY ROTATING BEACON ON TOWER, AND S. W. FLOODLIGHT BANK

2. Illuminated Wind Direction Indicator—There shall be at least one illuminated wind direction indicator, internally or externally lighted, equivalent in effect to the standard wind cone.
3. Boundary Lights—The outline of the usable portion of the landing area shall be shown at night by boundary lights spaced not more than 300 feet apart and served by an underground distribution system. Either series or multiple circuits may be used. The units must be weatherproof and white or yellow in color. In multiple circuits, at least 25-watt lamps shall be used and in series circuits, S-24½, 6.6 ampere, 600-lumen lamps. Where green lights are installed in the boundary circuit to designate favorable points of approach, 50-watt and 1,000-lumen lamps must be used in the multiple and series circuits respectively.
4. Obstruction Lights—All obstructions on or in the vicinity of the airport shall be clearly marked with red lights of the same wattage or lumen output as the green lights specified for the boundary circuit. Obstruction lights must be waterproof and shall be mounted in each case above the highest point of the obstruction. All tall, isolated obstructions in the vicinity of the airport exceeding 100 feet in height, such as radio towers, flagpoles, transmission towers, chimneys, and water towers shall be marked with at least two red lights placed directly above the obstruction, with one red light, or more, as may be necessary to give visibility in all directions, placed at two-thirds the height, and also at one-third the height of the obstruction. In lieu of such red obstruction lights, chimneys, water towers, and similar structures may be marked by adequate floodlighting.
5. Hangar Floodlights and Roof Marking—The exterior surface of each hangar on the airport shall be floodlighted to an average intensity of illumination of at least 2.5 foot candles. This may be accomplished by a system of at least 200-watt lamps with industrial reflectors mounted about 10 feet above the surface and spaced at 20-foot centers in each direction on the roof and along the eaves and ends of the roof, or by the use of floodlight projectors giving the specified intensity. The exterior surfaces of the hangars, excepting the roof areas used as the background for air markings, shall be of such a color as to reflect not less than 50 per cent of the light, and at least one hangar roof, or other suitable area shall be marked with the name of the city or town and so illuminated as to be visible from an altitude of at least 2,000 feet.
6. Ceiling Projector—For use as a ceiling projector there is required an incandescent searchlight with a parabolic reflector of not less than 12 inches diameter, equipped with at least a 250-watt lamp of the concentrated filament type used for spotlight or headlight service, and a stray light shield giving a beam spread of not more than 7 degrees; or equivalent apparatus. In some cases, depending upon local conditions, it may be necessary to use units as large as 24 inches in diameter, fitted with 1,000-watt lamps. The projector shall be mounted on a yoke with a quadrant or other suitable means for elevating and holding the light at the proper angle.
7. Landing Area Floodlights—The landing area floodlight system, which may consist of one or more units, shall be such as to provide an even distribution of illumination over the entire usable portion of the landing area. There shall be sufficient intensity of illumination to reveal the details of the surface and make depth perception readily possible from a minimum altitude of 30 feet in the center of the lighted area. The minimum vertical plane intensity of illumination over the usable portion of the landing area shall not be less than 0.15 foot candle.

   The floodlight system shall be immediately available for use at all times with the control station located at a convenient point, and shall be sufficiently flexible to permit landing under all conditions of wind direction without the necessity of landing directly into the source of light. There shall be sufficient light to illuminate objects and obstacles in the immediate vicinity of the airport in the direction of the beam, and the floodlight unit or units shall be so designed and installed as to eliminate glare and blinding of the pilot.

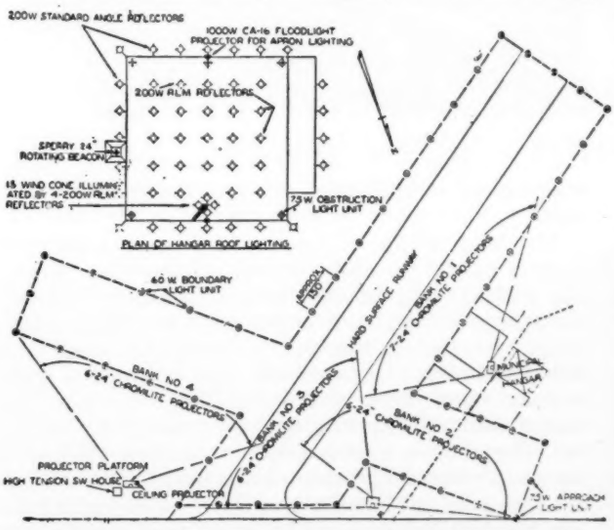
   Units shall be mounted as low as possible consistent with the contour of the landing area, and shall project a beam of small vertical divergence with a sharp cut-off at the top, and with top of beam as nearly parallel with and as close to the landing area as practicable. Units using more than one lamp shall be so constructed that the failure of one or more lamps will not interrupt the service of remaining lamps. When more than one unit is used, suitable provision shall be made so that the failure of one unit shall not interrupt the service of the other units. Where the floodlighting is accomplished from a single light source, an automatic light changer shall be provided to bring a new lamp into focal position in case of lamp failure. In lieu of a lamp changer, an auxiliary unit may be provided, which in case of failure of the major unit, will produce a minimum vertical plane intensity of illumination of not less than .035 foot candle over the usable portion of the landing area.

The lighting of the airport at Newark, N. J., is a good illustration of a lighting installation meeting the requirements of the Department of Commerce for Class A rating.

The rotating beacon is of the 24-inch Sperry standard type, equipped with an automatic lamp changer and 1000-watt, 115-volt, lamps.

The wind director is a fabric wind cone, secured to the top of the municipal hangar roof and lighted by four 200-watt, 115-volt lamps mounted in R L M standard dome reflector fixtures.

The boundary lights are spaced about 150 feet apart along the borders of the runways and consist of screw-type holders fitted with clear, prismatic globes and equipped with 60-watt, 115-volt lamps; while the approach lights at the ends of the runways are fitted with green globes and 75-watt lamps. These lights are mounted about 30 inches above the ground


200W STANDARD ANGLE REFLECTORS
1000W CA-16 FLOODLIGHT PROJECTOR FOR APRON LIGHTING
200W RLM REFLECTORS
SPERRY 24" ROTATING BEACON
15 WIND CONE ILLUMINATED BY 4-200W RLM REFLECTORS
75W OBSTRUCTION LIGHT UNIT
PLAN OF HANGAR ROOF LIGHTING
60 W. BOUNDARY LIGHT UNIT
BANK NO. 4 6-24" CHROMILITE PROJECTORS
BANK NO. 3 6-24" CHROMILITE PROJECTORS
HARD SURFACE RUNWAY
BANK NO. 1 7-24" CHROMILITE PROJECTORS
BANK NO. 2 5-24" CHROMILITE PROJECTORS
PROJECTOR PLATFORM
HIGH TENSION SW. HOUSE
CEILING PROJECTOR
75 W. APPROACH LIGHT UNIT

PLAN OF NEWARK AIRPORT, SHOWING LOCATION OF BANKS OF FLOODLIGHTS, WITH SECTORS ILLUMINATED BY EACH, RUNWAY MARKER LIGHTS, AND LIGHTING INSTALLATION FOR THE ROOF AND SIDES OF THE MAIN HANGAR.

END OF MAIN RUNWAY, NEWARK AIRPORT, ILLUMINATED WITH SIX WESTINGHOUSE CHROMILITE FLOODLIGHTS

and receive their current from a three-wire, 150/230 volt, underground circuit.

Obstruction lights fitted with ruby globes and 75-watt lamps are mounted on each corner of the hangar roof, with one unit on top of the wind cone support.

For hangar flood lights, the roof of the hangar is illuminated by an installation of R L M standard reflector fixtures with 200-watt, 115-volt lamps mounted 10 feet above the roof and spaced on 20-foot centers. The hangar sides are lighted by standard angle reflectors fitted with lamps of the same wattage. The aprons, in front of the hangar doors, are lighted by two type CA-16 Westinghouse Chromilite flood light projectors fitted with 1000 watt lamps and stippled lenses.

Perhaps the most difficult lighting is that of the landing area, especially when the surface is uneven, since the lighting should be fairly uniform over the entire usable portion of the landing area, with sufficient intensity to reveal all surface details without glare or shadows. The Newark field is lighted with twenty-five landing field floodlights, arranged in four groups or banks, equipped with 3,000-watt, 32-volt lamps. As shown in the illustration, banks Nos. 1 and 3 are used to illuminate the hard-surface runways, while banks Nos. 2 and 4 light the cross runway, thereby providing a flexible system which eliminates the necessity of ever landing towards the source of light. The several banks are operated from a remote control switchboard located near the municipal hangar.

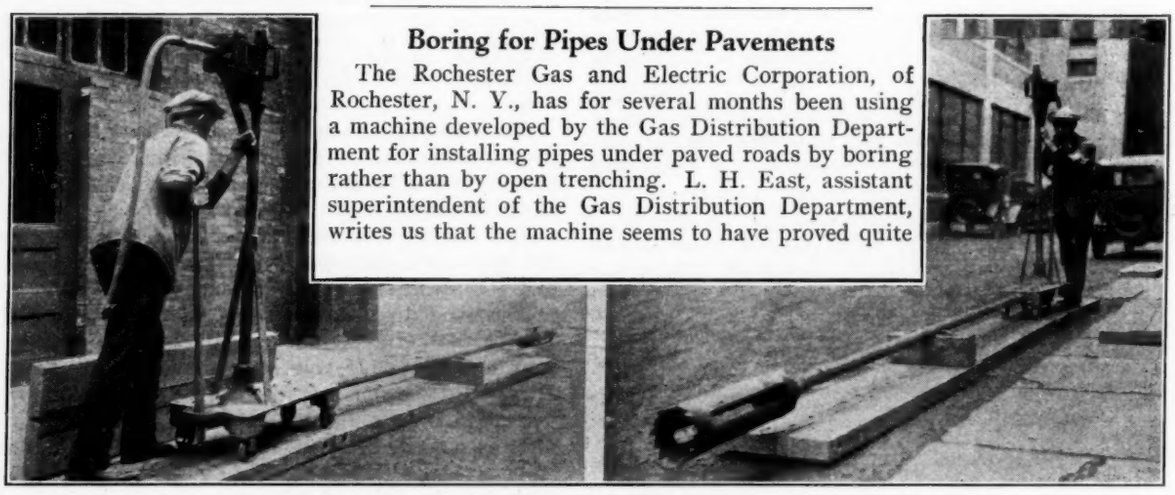
With the exception of the rotating beacon and the ceiling projector, all of the lighting equipment mentioned, as well as the transformers, panel boards and remote control switchboard, were supplied by the Westinghouse Electric & Manufacturing Company. The landing field floodlights are of the Chromilite type, which has been developed by the company especially for this purpose, and consists of a 24-inch drum-shaped body 19 inches deep, adapted to be mounted on a 2½-inch pipe standard; the body containing a reflector, a lamp socket and a system of louvers to absorb the upwardly directed rays of light. Equipped with a 3000-watt, 32-volt lamp and a 20 degree spread lense, this floodlight gives approximately 1,000,000 beam candlepower.

France Builds Roads From War Reparations

Last July the three departments of France comprising Alsace-Lorraine were awarded over 23,000,000 francs in cash and materials for the building and maintenance of country roads during the present year. While this award was made by the central government, the materials are all to be supplied by Germany as payment in kind of war reparation claims. The value of the materials to be supplied by Germany amounts to $845,590. The amount of money allotted by the French Government is $58,594 to be apportioned equally among the three departments.

Boring for Pipes Under Pavements

The Rochester Gas and Electric Corporation, of Rochester, N. Y., has for several months been using a machine developed by the Gas Distribution Department for installing pipes under paved roads by boring rather than by open trenching. L. H. East, assistant superintendent of the Gas Distribution Department, writes us that the machine seems to have proved quite a success in most kinds of soil and the department intends to do further development work with it, believing that a very substantial saving will result from its use. With it, the department has been able to bore holes up to 8 inches in diameter under pavements 24 feet wide, and through clay, hard pan, and in some cases clay containing small boulders.



APPLIANCE FOR BORING UNDER PAVEMENTS FOR INSTALLING PIPES

In the ordinary operation of the machine, the boring tool is fed in with a lever for a distance of about two feet, when it is withdrawn and the earth removed from the cutter, and the process repeated until the hole is completed its full length. In certain types of hard clay, it has been found necessary to bore a small pilot hole about 3 inches diameter first, and then ream this hole larger with one or two reamers. This plan will oftentimes work in soil containing stones and small boulders, since these obstacles are moved and turned so that they can be extracted from the hole.

The construction of the machine is illustrated by the two views of it shown above. It consists of a boring tool varying in size from 3 inches to 8 inches diameter; a Ford differential mounted upon a carriage and used to transfer the vertical rotation to a horizontal rotation, at the same time acting as a speed reducer; and third, a 2½ h.p. Ingersoll-Rand air motor driven by air furnished by a portable compressor. The whole is mounted upon a carriage which rolls upon a plank track; which track is provided in the center with a line of holes in a metal strip, in which holes are inserted the bottom of a lever used for pushing the boring machine ahead as the hole advances. The machine was constructed by the General Construction Department of the corporation.

Constructing Wanaque Aqueduct*

Blow-off manholes, air release and vacuum valves. Lining tunnel with reinforced concrete pipe. Plant and construction methods

By A. A. Jones†

Blow-off Manholes.—Blow-off manholes are principally of two types—free draining and pumping. Both types are circular, placed alongside the aqueduct pipe, with reinforced concrete base and plastered brick walls, the base extending under and supporting the aqueduct pipe. Connection with the aqueduct pipe is formed of a cast steel saddle and 45 degree elbow with flanged face to which are bolted two blow-off gate valves in tandem, the inner one being a stand-by and the outer having a stem rising to the top of the manhole. Blow-off saddles and valves are 8 inches or 12 inches, depending on the length of run to be drained.

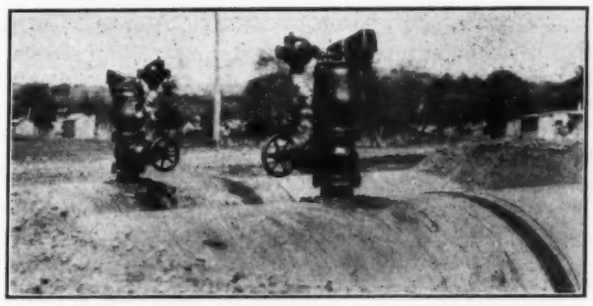
In the free draining type (that is, located at an elevation higher than a nearby water course) an elbow is bolted to the blow-off valve connecting an 8-inch or 12-inch cast-iron drain pipe leading to the nearest available free outlet. In the pumping type, the blow-off valve discharges directly into the manhole; and in draining a section of the aqueduct, when the water has been lowered to the elevation of the top of the manhole a portable pump will be used to remove the balance.

Air Valve Chambers.—The sizes and locations of air valves were selected with a view to prevent accumulations of air at summits in the line; to provide outlets for air, when the line is being filled, which will prevent water hammer; and to provide inlets for air which will allow the pipe to empty in a reasonable time, when required, without possibility of damage.

Air valve chambers are of six types which are, in effect, variations of a general type to suit local conditions and varying in dimensions to accommodate the required number of valves. These chambers in all cases are rectangular in plan with plain concrete base and reinforced concrete walls and roof slab. For twin lines, the chambers are of sufficient width to cover both pipes, the concrete base extending across below the pipes and rising, between the pipes, to their center line. An access manhole is provided on the center line between pipes, with standard cast-iron cover and supplementary frost cover, which is also a lock cover. On single line, the chambers are extended on one side sufficiently to give room for the access manhole.

Air valves are mounted upon the center lines of the aqueduct pipes by means of cast-steel saddles with flanged faces. In each assembly, a gate valve is placed below the air valves. In most chambers the gate is bolted directly to the saddle, but in certain stretches of the Morris Canal, where river flood waters may rise to sufficient height to submerge the aqueduct, a cast-iron riser pipe of sufficient length to bring the air valves above high water is inserted between the saddle and gate valve. In such cases, of course, the walls of the chamber are carried up to a corresponding height. The vacuum valve is bolted directly to the gate valve.

*Continued from page 335.
†Executive engineer, Fuller & McClintock, New York City.



COMBINED AIR AND VACUUM VALES

The "pot" of the vacuum valve has a tap in its side near the base by means of which the air release valve is mounted, two 45 degree elbows and a gate valve bringing the top of the air release valve level with the top of the vacuum valve. On 6-inch vacuum valves, the connection to the release valve is 2 inches, on 4-inch valves the connection is 1 inch.

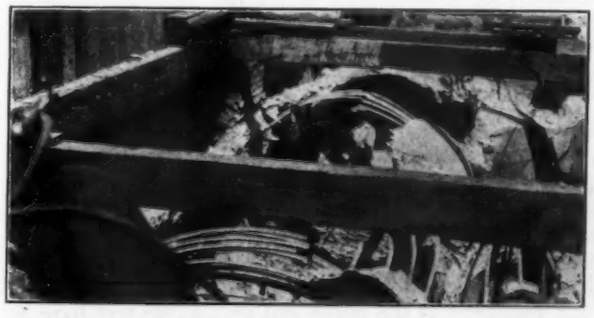
Each air valve chamber is vented by means of one or more 12-inch cast-iron pipes rising to 6 feet above the ground level. The vent pipe is provided with a ventilating cap at the top. At the bottom an ingeniously arranged box damper of 32-ounce copper with double-acting flap doors permits either ingress or egress of air as the vacuum or release valves operate.

Three feet of earth cover is provided above the tops of chambers, except those in the Morris Canal, which are carried above high water level. At these, earth is mounded up to the top of the roof slab.

Both vacuum valves and air release valves are made by the Simplex Valve and Meter Co.

Tunnel Reinforcement.—As the aqueduct was originally designed as a grade aqueduct, both the Wanaque and Great Notch tunnels and their approaches, built under previous contracts, were unreinforced against pressure. Both tunnels were lined with plain concrete, designed only to provide a covered water channel and to prevent infiltration. Under the present design, with steel pipe lines and pumping at the headworks, it became necessary to reinforce these tunnels against pressure. With full reservoir pressure, the Wanaque tunnel will be under a head of 70 feet; Great Notch tunnel of 100 feet.

For the reinforcement of Wanaque tunnel and its approaches, bids were taken on two alternative types of reinforcing; i.e., either 84-inch concrete pressure pipe or 88-inch riveted steel pipe with concrete lining and backing. The old tunnel lining is a horse-shoe shaped section 108″x108″, while the cut and cover approach is a circular section of 108″ inside diameter.

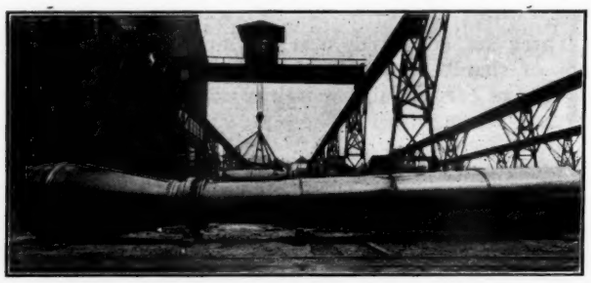


SECTION OF OLD AQUEDUCT TORN AWAY FOR REINFORCING BY INSERTING PIPE.

Due to the heavy overburden of waste material which had been placed over the south approach, this section, about 500 feet in length, was not re-excavated, but was reinforced in the same manner as the tunnel. At the north end, where the overburden over the old cut and cover section of about 200 feet was light, the overburden is being re-excavated, the top half of the old concrete section removed and 84-inch steel pipe laid in the lower half.

Contract for this work was let on March 20, 1929, to Lock Joint Pipe Company at its low bid price of $185,750 and this work is now being carried out by this company. In addition to reinforcement of the tunnel, this contract includes the 84-inch steel line connecting the tunnel with the headworks and the 84″x46″ Venturi meter.

The work of placing lock joint pipe in the tunnel has been carried out from the upper end, pipe being laid from the lower end to the upper. Each section of pipe, 12 feet in length and weighing 15 tons, was lowered into the excavation at the upper end of the work, where it was suspended in a 6-wheeled tunnel truck operated by a 4 H. P. gasoline engine. This truck, mounted upon a narrow gage track, is so devised that the pipe is suspended from an I-beam carried by a jack on the forward pair of wheels. As contact is



84″x46″ VENTURI METER FOR WANAQUE AQUEDUCT

made with the section previously laid, the projecting I-beam is rested upon a jack supported by blocks in the section already laid. The load being taken by the second jack, the forward pair of wheels is raised above the invert of the pipe by its supporting jack and the section is moved forward, inserting the spigot of the new section in to the "bell" of the section previously laid. This method of laying has proved eminently satisfactory and excellent joints have been secured. Caulking of the lead joints was carried on progressively with pipe laying. An ingenious arrangement of a concrete hopper mounted upon the truck permitted backing up concrete to be carried forward with the pipe. This concrete was spouted forward from the hopper and filled the space between the haunch of the horse-shoe shaped tunnel lining and outer surface of the pipe up to the springing line, where the annular space is 4 inches.

Two angles occur in the alignment of the tunnel, one of 7°-20′ and one of 15°-14′. No particular difficulty has been experienced in negotiating these angles in laying pipe by the method outlined.

The Great Notch tunnel is 9375 feet long, with a concrete lining 84 inches in inside diameter. The tunnel approaches are of concrete laid at grade, of horse-shoe section 7 feet high by 7 feet 8 inches wide, 625 feet long at the north end and 4,290 feet long at the south end. Cover over the tunnel is less than 100 feet for a distance of 750 feet from the north portal and 1500 feet from the south portal. Work of reinforcing this tunnel and its approaches has not been started. It is proposed, first, to ascertain, by testing with the aid of bulkheads, how much of the tunnel with adequate cover will stand the increased pressure, after grouting the lining to fill void spaces; second, to insert pipe into the tunnel from either end for whatever distance is determined by the tests; third, to substitute steel pipe for the concrete grade approaches. Seventy-four-inch steel pipe will be used for tunnel reinforcement, with 2-inch concrete lining and the annular space between the pipe and existing concrete lining filled with concrete under pressure. This work will be carried out by T. A. Gillespie Company.

TESTING

Both shop and field tests for watertightness are being carried out on all steel pipe. The shop test requirement is absolute watertightness under hydrostatic pressure of 175 pounds per square inch. This test is made on each 30-foot course of pipe and is checked by both shop and engineer's inspectors.

Requirements for field testing are pressure of not less than 100 pounds nor more than 125 pounds and total leakage not exceeding 8500 gallons per mile of pipe per 24 hours. For field tests, convenient sections are bulkheaded off, the line is filled with water from a local supply and pressure applied by means of a Barnes L73B, 5″x5″ double-acting plunger pump with 2-inch suction and 1-inch discharge, capable of delivering 3000 gallons per hour at 125 pounds pressure. This pump is equipped with an automatic pressure relief valve which, being set at the required pressure, maintains this pressure in the pipe line and bypasses all surplus water passed through the pump during the test. Leakage is measured by means of a 1-inch meter set in the discharge line of the pump.

Results of all tests have proven entirely satisfactory. In all cases actual leakage has been less than that allowable under the specifications. To date approximately 50,000 feet of pipe line has been tested. The result of the tests shows an average leakage of 7400 gallons per mile per day, against 8500 allowable maximum.

PLANT AND CONSTRUCTION METHODS

Lock-bar pipe is fabricated at the Leetsdale, Pa., shop of the East Jersey Pipe Co. and shipped to the job on flat cars equipped with special stanchions and blocks for supporting one length of pipe on another. By this double-deck arrangement, two 30-foot lengths are shipped in each car.

At the railroad siding the pipe is unloaded by locomotive crane or crawler crane and loaded onto Republic trucks and trailers. Along sections of the work in the Morris Canal, an industrial railroad is used for delivery along the trench, pipe being transferred from truck to car by skidways. Along other sections, pipe is delivered directly at the trench by truck.

Along the twin lines portion of the aqueduct, the contractor is using three Northwest drag lines with 65-foot booms and 1½-yard buckets for digging, spoil being deposited along the side of the trench opposite distributed pipe. For pipe laying, following closely upon trenching, a model 50B Bucyrus machine equipped with Diesel engine is used. Along the stretch of the Morris Canal, a Link Belt machine of the same capacity has been used for both operations

of trenching and pipe laying. By this method, the drag line excavated ahead for two lengths of pipe in parallel, reached back, picked up the pipe sections and laid them, then crawled forward for another "bite" of thirty feet. All of the drag lines and cranes are mounted on caterpillar crawlers.

In pipe laying, after each 30-foot section (weighing about 6 tons) has been lowered into the trench, the top of the upper end is slipped over the slightly tapered lower end of the section previously placed, and after two or three bolts or drift pins have been dropped in the upper rivet holes of the two sections, the section is gradually eased into place. Every third rivet hole is temporarily bolted and the pipe is then "layed up" by blows from a sledge hammer along the lock bars to bring the plates of the two sections into contact.

SHOVEL EXCAVATING TRENCH

The girth joint is formed of a single line of rivets. Riveting is done from the inside of the pipe by compressed air. Portable Ingersoll-Rand gasoline-driven compressors with capacities of 300 cubic feet of free air per minute supply air for riveting. In every third section of pipe there is a drop-hole for hose lines from the compressors. For bucking up, a dolly is made of a heavy sledge with its handle held by a heavy chain passing around the pipe to give leverage against the rivet head while the air gun is working inside the pipe.

Near the Pompton river, sufficient ground water was encountered to require more than usual pumping. A Mooretrench well point system and pump were installed and work proceded in the dry. For ordinary pumping of trenches, Thompson centrifugal pumps and Marlow Mud Hogs, both with 4-inch suction, are being used. For unwatering joint holes in the trench, 2-inch Trench Marine and Homelight pumps are used. At river crossings, larger centrifugal pumps are of

LEVELING BOTTOM OF TRENCH BY HAND

course required. In all, the contractor has on the job about one hundred pumps varying in size from 2-inch to 10-inch.

At this writing (August 10) the contractor is working at seven different points along the line. Of the larger items in the contract, 90 percent of the steel plate required has been ordered; 60 percent of fabricated steel pipe has been shipped; 50 percent of trench excavation has been completed; 50 percent of the pipe has been laid.

For the contractor, M. J. Coffey, vice-president and general manager of the T. A. Gillespie Company, is in charge of all work. Fuller & McClintock of New York are engineers, for whom D. W. Howes, construction engineer, has supervision of all field work, and A. A. Jones is executive engineer with headquarters at Newark, N. J.

Meter Readers and Dogs

The hazard of dog bites and the delay and general inconvenience occasioned by barking dogs to readers of water, gas and electric meters is one of the subjects discussed in the September "News Letter" of the National Safety Council. Harry M. Webber, of the Illinois Bell Telephone Co., stated that he receives the reports of employees bitten by dogs in Chicago, with name and address of the employee and the owner of the dog, and immediately turns over the information to the police department for action under the city ordinance covering such cases. Usually the owner is notified and the dog examined. In addition, a record is made on the subscriber's trouble card so other employees can be warned beforehand. This seems to work out very well as it is very rarely the case that more than one employee is bitten by the same dog.

J. M. Buswell, of the San Joaquin Light and Power Corporation, Fresno, California, stated that if they have difficulty in gaining entrance to any premises on account of a vicious dog, the meter reader or collector notifies the owner. If the condition is not remedied

AT LEFT, WELL POINTS FOR DRAINING GROUND ALONG TRENCH

and if a number of return trips are necessary to read, test or inspect the meter, the customer is notified that he must provide for confinement of the dog or relocation of the meter, or service will be discontinued, as it is impractical to continue the expensive second or third visits and still have employees exposed to the hazard.

In some cases the meter has been relocated on the outside of the house or in a box on a pole in the alley, usually at the customer's expense, but in some special cases the company has borne the cost. Employees are warned of vicious dogs and protected as far as possible.

In some cases they have found leather puttees a help, but the men find them uncomfortable in hot weather. One of the men put it this way: "Puttees used to be all right when dogs were little and most of them were short legged, but nowadays they don't do any good, especially if the *man* is short legged, because these German police dogs don't stoop when they bite, so the puttee is about two feet too short."

One of the men carried a small squirt can of ammonia and stated that if he couldn't "face the dog down" one shot of ammonia would generally settle the matter without serious injury to the dog. In any case, he generally had it out with the dog at the first meeting and thereafter, though the dog might bark at him, he never offered to bite.

Harold A. Briggs, of the San Antonio Public Service Co., San Antonio, Tex., said that his company supplies its meter readers with puttees but does not make the wearing of them mandatory. The thing that has helped most is a record of vicious dogs, and when one is reported they ask the owner as to the best way of getting in. Then a note is made on the meter slip: "Dog, knock at west door." "Dog, ring bell," etc. These precautions have been found effective.

Moving a Cement-Jointed Water Main

There have been a great many instances of the moving of water mains while carrying water under pressure, but these almost always have been lead-jointed mains, we believe. Recently, a main was lowered at Los Angeles which had been jointed with cement mortar; also, we believe the method of lowering was a novel one.

In 1923, a line of 24-inch bell and spigot pipe had been laid in Fletcher Drive using cement mortar for joints, the pipe having been laid practically parallel to the natural surface of the ground. Recently, a contract was awarded for improving the street, including grading which called for the lowering of high points, in places as much as four or five feet. This, of course, necessitated lowering the water main at these points, some sections being three to four hundred feet long. This main carried water at 90 pounds pressure and it was extremely desirable not to interrupt the use of the main during the process of lowering.

In beginning the operation, a trench was dug five or six feet wide, down to and slightly lower than the bottom of the pipe. The cement joints were then chipped out for a distance of approximately two inches from the face of the bell, the foreman in charge using his judgment as to the depth to be chipped out, but leaving enough to hold the pressure temporarily; immediately after which the bell was filled with lead poured in the usual manner but not calked.

Excavation of the trench was then carried below the main but leaving unexcavated a rib of soil about 2 feet wide at each joint so as to carry the weight of the pipe. When the excavation between these ribs had been carried down about 18 inches, the tops of the ribs were scooped out two or three inches below the pipe and the joint allowed to settle down on the rib again. Excavation between ribs was then continued and the rib again lowered until finally the pipe had dropped to its desired position. Occasional small leaks which developed during the movement were remedied by calking the lead with pneumatic calking tools.

Lowering the pipe in vertical curves of course shortened its length and this was compensated for by introducing slight horizontal curves in the line of the pipe to take the place of the original vertical curves. When the pipe had finally been lowered to place, all the joints were calked firmly.

Economy and Reliability of Diesel Engines

Figures from several operating plants and study of comparative costs of steam, electric and Diesel plants

A paper entitled "Experience With Diesel Engines in Waterworks Plants" was read before the New England Water Works Association by A. D. Couch, mechanical engineer of the Community Water Service Company, New York City, in which Mr. Couch drew upon the experiences of his company in the use of Diesel and other engines in a number of plants. The paper was illustrated by a number of lantern slides, the first of which showed a 60 h.p. diesel engine built in 1898 in a brewery at St. Louis and still standing on its original foundation, although it has not been operated for several years, probably because of the 18th Amendment. Although considerable improvements have been made in the mechanical details of the diesel engine, the efficiency of these old engines was remarkable and a record is available of a fuel test of one built over twenty years ago which would be acceptable today.

A survey of all diesel engines in use in the United States made in 1927 showed that approximately one fourth of all the horsepower was employed in pumping water, sewage and oil. This survey did not include the thousands of horsepower in semi-diesel engines. If the same proportion holds good today, approximately 750,000 h.p. of diesel engines is now applied in some form of pumping in the United States. There are no figures available to indicate what percentage are operated in waterworks, but Mr. Couch believes that this is one of the best fields for diesel engines.

As a contrast to the early 60 h.p. engine, he showed a photograph of a 15,000 h.p. engine (believed to be the largest diesel engine in the world) built by Messrs. Blohm and Voss of Hamburg, Germany, and operated in the municipal power station at Hamburg. This is a nine-cylinder, double acting, two-stroke cycle engine.

In order to illustrate the efficiency of a disel engine as compared to steam and electricity, Mr. Couch gave

a tabulation, compiled about two years ago, comparing the cost of operating an existing plant with the calculated cost of substituting other forms of power. This plant contained three horizontal tubular boilers of about 125 h.p. each and two horizontal duplex triple expansion pumps. The equipment had a send out of three million gallons per day and was in very good condition. It was thought possible, however, that the economy obtained in this plant might be improved upon and a comparison was made as shown in the following table:

Table No. 1—Steam—Electric—Diesel Comparison

ITEM	YEARLY COST			
	Steam*	Electric**	Diesel**	Diesel***
Coal @ 6.50.....	$12,869.	$ 360.	$ 360.	$ 302.
Power @ 2c.....		22,200.		
Fuel oil at 6.7c..			7,350.	7,034.
Lubrication	800.		420.	496.
Engine Repair .	1,000. (Includes boilers & aux.)		400.	172.
Pump Repair ....(Includ-	above)	200.	150.	
Labor	13,275	6,000.	7,800.	5,396.
Supplies	1,000.		250.	398.
Operating Total ..	28,944	28,760b	16,730b	13,798c
First Cost a		7,100	43,500	43,000
Fixed Chgs.—15% .		1,065	6,525	6,450
Operat'g + Fixed..		29,825	23,255	20,248
Million gallons	800	800	800	923
Aver. ft. head.....	335	335	335	309
Million Ft. Lbs....	2,220,000	2,220,000b	2,220,000b	2,462.044c
Oper. cost/M.F.P..	$ 0.01304	$ 0.01295	$ 0.00754	$ 0.00560
Oper.+fixed/M.F.P. .		$ 0.1343	$ 0.01048	$ 0.00822

*Average—Five Years; ** Estimated; *** Actual.
a Less Building; b Without Aux. & Light Power; c With Generator included.

The figures shown here are not merely hypothetical, worked out for the purpose of this paper, but are the actual figures tabulated at the time the study was made; with the exception, of course, of the last column, which could not be obtained until the new plant had been installed and operated. The first column was arrived at by averaging the costs of the last five years of steam operation. The first cost of this plant is not shown for the reason that a twenty-year old cost would not be very enlightening today, nor would the same equipment be installed in a new steam plant.

The second column represents an estimate of the operating costs that would be expected if motor-driven centrifugal pumps were installed and the power purchased at 2 cents per k.w.h., which was the best rate obtainable. The yearly operating cost for such a plant was found to be practically as great as for the existing steam plant and there would, of course, be no advantage in making this change. There might be such advantage if current could be bought at a considerably lower rate; but it would have to be bought at 1.1 cents per k.w.h. to meet the final figures in the last column, the actual cost with diesel engine operation.

The third column represents an estimate of the diesel installation, while the last column shows actual cost covering the first year's operation. One reason why the total cost was so much lower than the estimated was that the send out increased by more than 100 million gallons over the estimated figure. Also in the matter of engine repairs, the estimate is given as $400 and the actual cost as $172. It is a well-known fact that repairs to a diesel engine increase year by year up to the fifth year, when the maximum is reached and considerable maintenance work is necessary. The engine should then be rendered practically as good as new, when the cost cycle will return to the first-year condition. Four hundred dollars was believed to represent a fair average for a five-year cycle.

The third column shows a total operation cost of $16,730 as against the actual costs by the old plant of $28,944. On a basis of 15% fixed charges per year, a diesel engine plant would be justified costing $80,000, retaining the old steam plant for standby purpose only. The estimated price for a diesel installation was $43,500 (the actual cost was about $43,000). Adding the 15% of this to the yearly operating cost gives a total cost of $23,255 as compared with $29,825 annual cost for a motor-driven plant with purchased power.

As the steam plant was already in service, comparison was made between the total annual cost for the diesel plant and for the electric plant, and the operating cost of the steam plant, and it was seen that the diesel plant was the only one which would be economical to install. A 338 h.p. diesel engine arranged to drive a 3-million gallon per day centrifugal pump through a 400 h.p. step-up gear was installed; also a 25 k.w. generator connected to the pump shaft to generate current for lights, low-lift pumps and other auxiliary power plant requirements.

In showing a number of photographs of the new plant, Mr. Couch called attention to the speed control on the switchboard, which allows a speed variation sufficient to provide for the whole capacity range at the pressure maintained in the main. A variable speed motor would be required to give this same flexibility to a motor-driven pump, and even so the losses ensuing from variable-speed motor control would be considerably greater than is the case with variable-speed diesel operation.

He also called attention to the lubricating oil separator, which operates continuously, stating that "to preserve good lubrication, a separator of this sort is one of the most essential auxiliaries of a diesel plant."

In concluding his description of this station, he stated that the duty of this plant was actually found, in the guarantee test, to be 354,400,000 foot-pounds per 100 pounds of fuel consumed, or slightly better than the guaranted duty of 348,174,500.

Following this description, Mr. Couch gave a comparison of the economies for different types of plants of the Community Water Service Co. using oil engines, which figures are given in table 2. These are

Table No. 2—Table Showing Economies for Different Types of Drives

	Plant No. 1	Plant No. 2	Plant No. 3	Plant No. 4
Kind of Plant	Pump Geared Centrifugal	Pump Geared Triplex	Elec Gen. and Motor	Air Lift and Triplex
Type of Pump—Low Lift	None	None	Cent.	Air Lift
High Lift	Cent.	Triplex	Cent.	Triplex
Pump Drive—Low Lift	None	None	Elec.	Dir. Connected
High Lift	Stepup Gear	Stepdown	Elec.	Belted
No. of Engines & H. P.....	1-338	1-40	2-360	1-60
Gal. Per Day—Low Lift	.....	.....	1,900,000	125,000
Total Head in Ft.—Low Lift	.....	.....	35'	100'
Gal. Per Day—High Lift	2,880,000	700,000	1,860,000	125,000
Total Head in Ft.—High Lift	307'	190'	286'	248'
Mil. Ft. Lbs. Per 100 Lbs. Fuel Oil	324	264	205	148.6
Oper. Cost Per Million Ft. Lbs.	$0.00515	.....	$0.00723	$0.0242

the actual figures from the records of that company for the month of May, 1929, which is considered a fair example, since this month is neither the lightest nor the heaviest of the year.

This comparison indicates that the direct gear-driven installations are the most efficient, and the air-lifting installation the least efficient. In plant No. 2, the triplex pump takes its water directly from wells and has a lift of about 22 feet. "This type of installation is probably the lowest in first cost which can be obtained for the smaller plants. Water was needed badly on this property and it became necessary to put the equipment of service before all the 'bugs' had been worked out. However, the equipment has been shut down for only a few minutes since then, for minor adjustments."

Table No. 3—Average Operating Cost of Steam, Electric and Diesel Plants

	Steam	Purchased Power	Diesel
Mil. gal. per day.....	8.17	2.35	2.88
Average head in feet.....	316	341	Plant
Mil. ft. lbs. per month.....	669,887	207.485	No.
Efficiency wire to water....	...	71.2%	1
Coal tons per month.....	620	...	...
Oper. cost per mil. ft. lbs...	$0.00818	$0.0063	$0.00515

In table 3, the author made a comparison between costs of steam plants, purchased-power plants, and diesel plants, selecting three good average plants operated by the Community Water Service Co., the diesel plant being the one described earlier in the paper. These records were also taken for the month of May, 1929. The steam plant contains triple expansion Corlis valve pumping engines and is located where coal can be delivered in the bin for approximately $3.33 per short ton. The purchased-power plant buys current for approximately 1¼ cents per k.w.h. It may be said, however, that these figures do not indicate that diesel engines are always the kind that should be installed in any station under all conditions. If diesel engines would fit every case, there would be no necessity for making comparative estimates such as that given above. "When the Community Water Service Co. investigates any particular situation, it does so with an entirely open mind and without any desire to install any particular kind of equipment. It often appears that equipment of a certain kind is installed which does not exactly fit the case, due to the particular desires and prejudices of the purchaser, and perhaps which excluded the diesel engine when this type of equipment should have been installed."

Concerning the reliability of diesel equipment, the author stated that he knew from his own experience that doubt of this is natural, for he remembered the anxiety he felt over the purchase of the first diesel engine he was expected to operate, which was installed in 1914; but this engine is still in operation today and its economy now is no doubt about the same as in 1914. He referred to the quite general and growing use of diesel engines in ships, where reliability is exceedingly important.

He quoted Dabney H. Maury as saying, at the Toronto convention of the American Water Works Association: "Diesel engine plants are more reliable than steam plants." He also quoted C. O. Romig, who manages a plant of the Community Water Service Co. which contains two 360 h.p. engines, as saying: "We have come to the conclusion that most diesel engine troubles can be avoided by inspecting the parts that can fail. An interested engineer rarely needs to be in trouble. We may have more trouble during the next four years than we have had during the past four, but to offset this, we know better how to take care of the engines and where to look for trouble." In this plant, which was installed four years ago, there are duplicate units—as there should be in any plant, no matter what the prime mover—and pressure has never been off the mains for a moment.

"In conclusion," said Mr. Couch, "it may be said that if duplicate diesel engine equipment is installed in any plant, no complete shutdown should occur if the machinery is given good care and attention; and that the reliability of diesel engines under these conditions will equal that of any steam equipment and will exceed that obtained with purchased power—especially so if the power comes in over long transmission lines, as is the coming tendency today."

Dubuque's Air-Lift Pumping Plant

Reasons for selecting deep-well supply rather than shallow wells or river, and air lift rather than other type of pumping plant

In his annual report for the year ending March 31, 1929, J. W. McEvoy, superintendent of the water department of Dubuque, Iowa, describes the air-lift pumping plant of that city at some length; from which description the following has been abstracted:

Until a very few years ago, the city obtained its supply from two sources. About half was from a group of wells in sand averaging 6 or 8 inches in diameter and about 100 feet deep, all connected to the suction of a steam-driven pump, which discharged the water into a surface reservoir of 400,000 gallons capacity. The suction of this pump was also connected to a sand well 8 feet in diameter. The daily capacity of this supply was 1,570,000 gallons. Four artesian wells ranging in depth from 1300 to 1450 feet gave a natural flow of 1,016,712 gallons, which could be increased to 1,779,840 gallons when suction was applied by a motor-driven centrifugal pump. The water in the surface reservoir was pumped by steam to a large 7½-million gallon reservoir located on a bluff at an elevation sufficient to serve most of the city; a standpipe being used to serve the highest portions.

In 1922 it became apparent that the capacity of the water supply must be increased and the city engaged the firm of Mead & Seastone of Madison, Wis., to report on the subject. They considered obtaining water from the Mississippi river with filtration, installing wells in sand, and boring additional artesian wells into St. Peter's and Potsdam sandstone. Although the Mississippi river would give an unlimited supply, the cost of a plant, including filtration, would be much greater than that of one for using either of the other sources, and cost of operation would be greater also. The water obtainable from the sand at a depth of about 100 feet apparently has been decreasing in quantity for a number of years past, and there is a mutual interference between wells. The available draw-down from the hydrostatic level to the

bottom of the sand stratum was only 85 feet, which did not allow increasing the supply from a given well as much as was desired.

For these and other reasons, but especially because of their apparent reliability as to quantity and endurance, it was decided to use artesian wells. Another argument in favor of these was that, while the hydrostatic level of the water in the shallow sand wells is 15 feet below the surface, that of the artesian wells is 23 feet above the surface. When artesian wells were first drilled at Dubuque, the water rose to 100 feet above the surface, but fell rapidly as wells multiplied. However, there has been very little fall in the static head for a number of years past and it is not believed that the use of a few additional wells would appreciably lower the head. The four artesian wells already in use were found to yield 28.7 gallons per minute per foot of draw-down, and it was calculated that by lowering the water level to a depth of 100 feet below the ground surface, a total of 5,100,000 gallons per day could be pumped from them; while tests with the shallow wells indicated that the maximum quantity obtainable would be 4,970,000 gallons per day. As a supply of more than 6,000,000 gallons per day was desired, it was thought advisable to figure on one additional artesian well.

Having decided upon the source of supply, it remained to adopt a method of pumping which would prove most economical over a period of years and yet be reliable and satisfactory. A comparison was made between the air-lift and motor-driven deep-well turbine. The actual pumping efficiency of the latter is better than that of the air-lift, but "it is found that by the use of proper machinery, the total cost of raising water by means of the air-lift was shown to be less than with deep-well pumps, taking the over-all efficiency from wier to water and making due allowance for maintenance and repair expenses. The simplicity and reliability of the air lift, particularly the absence of moving parts below the ground, requiring oiling and subject to wear, make it a more satisfactory method of pumping than centrifugal deep-well pumps with high-speed runners and long shafts and bearings located at inaccessible places deep in the wells.

"With the air-lift system, all the moving parts are located in the power house, where they can be under constant inspection." The relative advantages and disadvantages were summed up by Mr. McEvoy as follows:

"(1) The air lift is dependable, simple and durable, and will deliver water year in and year out with small chance of interruption of service by breakdown of the plant; (2) modern air-lift practice secures very high pumping efficiency, and this efficiency is maintained for long periods of time. With the deep-well turbine, due to wear, the efficiency is highest at the start and is continually decreasing; (3) more water can be obtained from a given well by the air lift than with any other method. With air, the wells can be backblown and cleaned; in this way keeping them up to their original capacity, and even increasing the first delivery due to opening up the pores in the sandstone; (4) the air lift is more flexible. Water may be pumped at widely varying rates without materially lowering the efficiency. A change in pumping level will not change the efficiency. A group of wells may be operated from a central point, which means minimum attention to the machinery. The main objections to the use of the deep-well turbine are: (1) the rapidly moving parts which are located in the well require constant replacing, which is a costly operation; (2) sand, causing rapid wearing of parts while it has no effect on the air lift; (3) the deep-well turbine cannot efficiently follow the water to a lower level and will not pump efficiently at varying capacities; (4) the well cannot be kept clean and will clog with sand and mud."

With the reservoir capacity provided, all pumping except in emergencies could be done in the local power company's off-peak period, or from early evening to late morning, and therefore very reasonable rates for electric current were obtainable, and electricity was selected as by far the most economical source of power.

Contract for installing the air-lift system was let to the Sullivan Machinery Co., which supplied two units of the Sullivan Class WJ 4, size 20—12x14", belt-driven compressors, each having a capacity of 2,428 cubic feet per minute. These machines are operated by 400 h.p. synchronous motors. Each well is equipped with a Sullivan "central" type 8x2½" air-lift footpiece, and a Sullivan cyclone booster. The boosters, which are placed in concrete pits entirely below the ground surface, are used to elevate the water to the surface reservoir, which is at a higher elevation than the tops of the wells.

A test of the air-lift system was made in September and the result showed a total pumpage of 6,475,000 gallons a day against an average total lift of 128 feet, with an air consumption of 0.442 cubic foot per gallons of water, the guarantee having been 0.490 cubic foot. The total horsepower required was 412 as compared to a guarantee of 482 h.p.

There were also installed, at the same elevation as the distributing reservoir, two motor-driven centrifugal pumps, automatically controlled, to pump water from this reservoir to the standpipe.

Designing Rapid Sand Filters

Problems to be considered and some of the data used in designing a plant. Standardized details and devices

A paper describing concisely but quite comprehensively the data required for designing rapid sand filters was presented at the fourth annual Missouri Water and Sewage Conference by A. W. Livingston and E. W. Bacharach & Co. of Kansas City, Mo. The authors named as the object of this paper, the information of water works superintendents, city officials, and filter operators, concerning some of the problems which the consulting engineer has had to consider in designing a plant. They restricted the paper to design data pertaining only to the filter unit itself, without attempting to cover the design of chemical plant, mixing chamber, sedimentation basin, clear-water well, etc.

Although originally rapid sand filters were built circular and of wood or steel, they are nowadays almost always built rectangular and of concrete; the concrete giving durability, while the rectangular shape eliminates waste of space, serves better as a foundation

for supporting the enclosing building, and is more adaptable to efficient under-drainage and wash-water distribution.

For average conditions, the capacity of a filter to be used for domestic supply is based on a rate of flow of two gallons per minute for each square foot of sand bed area. If used for clarification only, without regard to removal of bacteria, this may be increased to three or even four gallons per minute; while on the other hand, if it is to purify a highly contaminated water or if it is used with a mixing chamber or settling basin of low efficiency, the rate should be reduced below two gallons per minute.

As a general rule, the length of a filter should be from 10% to 30% greater than its width; this shortens the length of pipe gallery and operating floor, thereby reducing cost of pipe and the distance that the operator has to cover in order to manipulate the filter valves and devices. Moreover, wash water troughs and strainer systems can usually be better adapted to the long and narrow filter than to a short and wide filter or an absolutely square unit.

A common capacity of filter unit is one half million gallons per 24 hours, and such unit is usually built 15 feet long by 12 feet wide, and patterns for underdrain systems and wash-water troughs have been made by all equipment manufacturers for this standard size. To obtain the same capacity by making a filter 20 feet long by 9 feet wide not only would require a special construction of these filter appurtenances, but it would be difficult to arrange strainer systems and wash-water troughs for uniform distribution and the valves, valve stands and other appurtenances would be crowded.

In most of the plants the depth of gravel runs about 18 inches, and the depth of sand on the gravel about 30 inches, giving a total depth of about 4 feet. As explained later, the wash-water troughs are usually placed about 2 feet above the top of the sand; and a free-board is required above the top of the wash-water troughs, for which about 2 feet is allowed; giving a total depth of the filter box of about 8 feet. The authors consider it poor practice to reduce this depth by more than a few inches under any conditions.

Originally the underdrain system was designed to accomplish three purposes: first, collect the filtered water from under the gravel bed; second, distribute the wash water; third, prevent the passage of fine sand from the filter. Nowadays most practical filter engineers realize that a properly graded gravel bed can be relied upon even more than a strainer system to accomplish these results. With improvements in the design of gravel beds, the old strainer system has been robbed of some of its principal functions, and the writers believe that the old form of perforated pipe laterals is equally as good as any of the more modern types of strainer systems, of which many have been developed. Comparisons of such systems should be made chiefly upon the relative friction loss, durability, economy in first cost and maintenance, and easy access for cleaning and repairing.

The gravel bed placed over the underdrain system is the most important element in the filter. It is built up of different sizes of gravel, placing the largest at the bottom, and gradually reducing the size by layers towards the top, giving a total depth of 18 to 24 inches. Different sanitary engineers have developed specifications for such gravel beds, but all are now practically uniform. A typical illustration is as follows:

On the bottom, four inches of gravel passing a screen with circular openings of 2½ inches and retained on one of 1½-inch openings; next four inches of 1½ to 1-inch gravel, then four inches of 1 to ½-inch gravel, then three inches of ½ to ¼-inch gravel, and finally, three inches of ¼-inch to 1/12-inch gravel.

On the gravel is placed the sand, usually to a depth of 30 inches, although in some cases this has been made only 27 inches or even slightly less. It should have a high specific gravity and contain a minimum amount of perishable substances such as lime. Filter sand ordinarily has an effective size of between 0.40 and 0.50 m.m. and a uniformity coefficient not exceeding 1.7. Sand finer than this offers an undesirable obstruction to the passage of water through the filter and is more apt to be floated away during washing of the filter. The more uniform the size of sand grain, the less the likelihood of unequally disturbing the sand during washing. Some prefer sharp grains of sand and some rounded, but the sharp grains will become more or less rounded in time through agitation by washing the filter.

Wash-water troughs should be of sufficient size to carry off the wash water freely when running not quite full. The top edges of all the troughs should be absolutely level and in the same horizontal plane in any one filter. The distance of the edge of the trough above the sand depends upon the rate of wash water that is to be used; but if too high, much of the heavier sediment brought up by the wash water will settle back onto the sand before reaching the edge of the trough; while if the trough is too low, sand will be carried over the edge into it and removed by the wash water. The common practice is to place troughs about three and a half feet apart. If placed too far apart, the horizontal travel of the water may be great enough to allow the dirt to settle back onto the filter before it reaches the trough.

If a filter is to maintain a uniformly high efficiency, the rate of flow must be kept within the limits of its capacity and there must be no sudden changes in such rates. This result is obtained by use of an effluent rate controller placed on the outlet pipe of each filter unit. Different types of controllers are to be compared on the basis of their ability to maintain, with a minimum of error, any rate for which it has been set, irrespective of the changes that take place in pressure within the filter; facilities for regulation of the controller for any desired rate without undue loss of time or trouble; gradual response to such changes in rate without sudden shock; simplicity of design and minimum loss of head required for operation; and durability, economy of maintenance and repair, and accessibility of moving parts.

As the filter is operated, impurities collect and build up a resistance to the passage of water through it, until finally it will fail to yield its normal output. Most efficient results are obtained if the filter is washed just before this drop in output occurs; since, if washed oftener than this, there is needless waste of wash water; while if allowed to operate under decreased capacity, it not only may fail to meet the requirements for filtered water, but there is a possibility of so compacting the sand as to require excessive washing and consequent disturbance of the filter

materials. A device known as a loss-of-head gauge indicates to the filter operator the proper time for washing the filter.

The operating valves of a filter may be controlled manually, hydraulically or electrically. Electrically operated valves fulfill all the requirements of the hydraulic valves as to ease of operation and saving of labor, but are not as dependable, their cost is exceedingly high, and they are not popular with filter designers. Hand-operated valves entail loss of time and extra effort, the valve stands used to manipulate them detract from the appearance of the plant, and there seems to be no argument in favor of them except that of cost. In large filter plants, hydraulically operated valves are imperative because they are so large as to be unwieldy to manipulate by hand and hydraulic operation saves both labor and time.

Other devices useful in connection with rapid sand filters are gauges for indicating or recording the rate of flow of water through the filter, appliances for obtaining samples of water from different parts of the filter plant, and wash-water rate controllers for maintaining a unform rate of wash water to each filter.

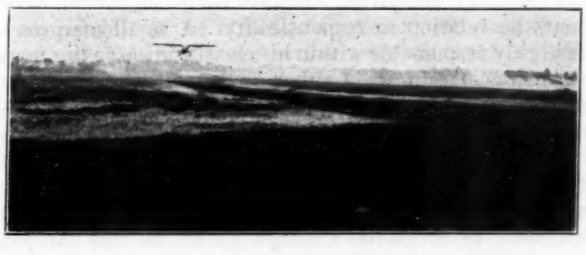
Central Airport, Camden, N. J.

The Central Airport, Camden, N. J., is nearing completion and already is being used as Philadelphia's air mail terminal, it being but twenty minutes from the business center of that city via the Delaware River bridge. By the middle of September three hangars had been erected, the administration building was under construction; and boundary lights at 200-foot intervals, obstruction lights, flood lights and a 3,000,000 candlepower beacon had been installed.

The soil is about 10 inches of loam overlying a subsoil of sand; consequently there was no trouble with wet grounds and no pipe drainage was necessary.

About 7,000 square yards of aprons and taxi-ways have been built around the two main hangars, and two runways, each 50 feet wide and 1,000 feet long, joined in the form of an L, are in service. These have a combined surface of 18,000 square yards, which has been surfaced with slag and asphalt. A cinder foundation was laid and thoroughly rolled, and on this a surface of slag penetrated with hot asphalt, on which slag chips were spread and rolled in. This was followed by a second application of asphalt and fine chips, and the surface was then finished with a light coat of cut-back asphalt which sealed it and assisted in holding the chips in place. The cost of this treatment was 70 cents a square yard. It appears to be perfectly satisfactory in all weathers.

The runways are used only for taking off, the rest of the field, which is in grass, being used for landing; and in the vicinity of the landing area, where there is considerable travel, trouble is experienced with dust and it is proposed to treat this area with light road oil; also to lay a cinder-asphalt taxi-way from the hangars to the administration building.



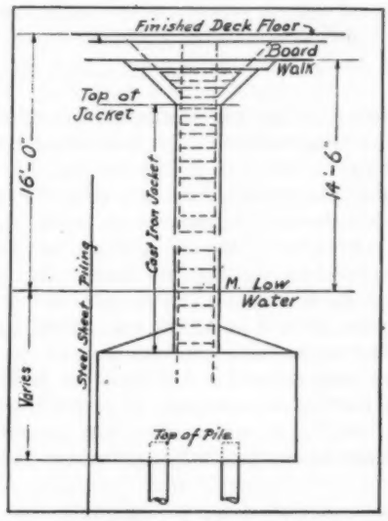
RUNWAY AT CENTRAL AIRPORT, CAMDEN

William A. Hemphill is chief engineer for the Airport Development & Construction Co. consultants, and Mr. Beck is in charge of construction for H. E. Baton, Inc., the contractor.

Ocean Piers Protected by Cast-Iron Pipe

A year or two ago, in building an addition to the steel pier at Atlantic City, the supporting piers were made of reinforced concrete poured inside of lengths of cast-iron pipe. The pipe thus not only served as a form for the pier, but, being left in place, protects the concrete from the mechanical and chemical action of the ocean, including the blows and abrasion of timber and other floating bodies, while barnacles are much less likely to attach themselves to it than to the rougher surface of concrete.

Recently a similar type of construction has been used in building the new Casino, at Asbury Park, N. J.; except that, while the Atlantic City installation used the DeLavaud pipe, set with the bells up, the Asbury Park construction used sand-cast pipe, set with the bells down so as to minimize the accumulation of moisture or debris on the bell.



SKETCH OF TYPICAL PIER

The pipe used varied in diameter from 20 inches to 54 inches, and in length from 6 feet to 18 feet 10 inches; the smallest size being used where the load to be carried did not exceed 120,000 pounds; while the 54-inch pipe were used to carry loads up to 1,380,000 pounds. Piers so constructed were used to support the entire structure, which is 270 feet long by 150 feet wide.

In placing a pier, a circular steel sheet pile caisson was driven and the sand inside it was excavated by means of a sand pump and syphon. Wood piles were driven inside the caisson and their tops covered with a coat of tremie concrete. The iron pipe was then set in place and the top held in position by means of a wooden yoke which gripped the top of the pipe and rested on the top of the sheet piling. Steel reinforcement for the pier was made up and placed inside the pipe and the concrete poured for both footing and

pier by means of a tremie. The pier casings were delivered complete as to length; the joints, where the depth required more than one length of pipe, having been made at the foundry of the U. S. Pipe & Foundry Company, which furnished the pipe.

College Classes for Municipal Employees in City Hall

Special college courses in water, power, and police department training are announced by the University of Southern California; also courses dealing with surveying and highways for draughtsmen, junior engineers and surveyors; a course in banking and finance, dealing with property valuation, for executives, attorneys and engineers working under special improvement acts; a course in regional planning for members of highway commissions, highway engineers and interested citizens; and others making a total of 26 courses, including accounting, mathematics, science, English and sociology, are to be held in the Los Angeles city hall; the main object of holding the classes at this place being that it is the locality most convenient for the 25,000 city and county employees who may wish additional education to fit them for advancement.

PREQUALIFICATION OF BIDDERS ON PUBLIC WORKS CONTRACTS

By Philip A. Beatty, M. Am. Soc. C.E.*

The subject described by the above title has been receiving constantly increasing attention from contractors, engineers and public works officials during the past two or three years. It is of interest to all classes who are in any way connected with the construction of public works; but many such are still in some doubt as to just what prequalification contemplates and whether or to what extent it is desirable. Mr. Beatty's article, which appeared in the August issue of "Public Management," is the best concise presentation of the subject that we have read.

Prequalification in this discussion means the determination of responsibility of a contractor before permitting him to bid on public works. Advantages claimed for prequalification are that the awarding officer avoids the embarrassment of rejecting an irresponsible contractor's low bid and the importunity of those interested in writing his bond. He avoids the criticism of those who would impugn his motives; and an injunction, should he attempt to award to a higher bidder. The unqualified contractor saves the time and expense of preparing his bid and the publicity and injury of having it rejected. The qualified contractor meets intelligent and responsible competition and does not have to compete with ignorance and recklessness.

Law and medicine have for centuries required prequalification of their practitioners. In many states engineers and surveyors must be examined and licensed before practicing. Real estate brokers are to be licensed in Pennsylvania. Candidates for city employment must qualify before the civil service commission. Professions and trades prosper by closing their portals to promiscuous practitioners, and the public is much benefited by the restraint placed upon the irresponsible.

Prequalification is favored by responsible contractors, for without this safeguard they find their work snatched from them by inexperienced men whose underestimating frequently leads to default; by gamblers, who bid low and hope for "lucky breaks;" by sharks, who make up for low bids by shoddy workmanship, bribing inspectors and beating subcontractors and material men. Public officials favor it because it tends to relieve officials of the responsibility of rejecting low bids or trying to wring good work from incompetent contractors.

*Staff engineer, Bureau of Municipal Research of Philadelphia.

CONDITIONS IN CONTRACTING REQUIRING A REMEDY

In most places at present anyone can bid on public works; and the more he underrates the difficulties, the more cost items he forgets to include, the better his chance of being the low bidder. The huge building programs of late years have caused a heavy flow of new men to this field. In the recent man and mule-power days, many got a sound start with little beside energy and a vocabulary. But work is now heavier and more dangerous. It requires more capital and more management, and money can be lost more rapidly. The time element is vital; machinery is supplanting man and mulepower; steel and scheduled work have supplanted lime-mortar masonry and leisure. The contractor must be more than a constructor. He must know markets and buying, mechanical equipment, organization, management, cost-keeping. This knowledge is not generated spontaneously in the contractor. He must learn through a long apprenticeship with one who knows.

Responsibility vs. Irresponsibility.—Between responsibility and irresponsibility the difference may be small but vital. In meaning, "responsibility" is elastic. Size bears no relation to responsibility. A small man may be highly responsible within his classification; a big man out of his classification either as to kind or magnitude may be irresponsible. Either, within his classification, may overload and become irresponsible. Whoever incurs a responsibility which he cannot fulfil or can fulfil only by a fluke, or loss to others; whoever takes a gambler's chance, or expects to win by unethical methods, or overloads through greed, or robs the job to pay extraneous debts, is irresponsible.

The committee on ethics of the Associated General Contractors of America has attempted to define "responsibility,"[1] as used in that organization's motto, "Skill, Integrity, Responsibility." Their definition is "knowledge, ability and will-to-do." Knowledge is the "fruit of long and varied experience, acquired under someone who furnished the responsibility." Ability to organize, to sense market conditions, and to execute has to be developed under similar tutelage. Will is compounded of "honesty, loyalty, self-repect, optimism, resourcefulnes, and courage, not one of which can be lacking." The committee requires the contractor to have (1) previously executed a similar contract of at least half the amount of his bid; (2) ample and suitable equipment definitely available; (3) a clean record of past contracts, successfully fulfilled; (4) a general high reputation founded on consistent performance and good character; and (5) a net worth of sound and liquid assets equal to 20 per cent of all the work under way, including the new bid.

Survival of the Irresponsible.—Many contractors would never start or would soon fade from view but for help from those whose interests would be best served by their elimination—namely, the awarding official, the surety company, the equipment and material men, and the responsible contractors. Without bond, they could not get the award; but their credit rises with the award in prospect so that they can get the bond. Once they have the award and the bond, equipment and material men extend credit, being further protected by the lien laws. Without support, however, from their responsible contractor clients, who pay their bills, equipment and material men would fail.

The Responsible Contractor's Handicap.—The responsible contractor in his bid must take account of all costs, including overhead and equipment. Each expense must be reflected in his estimate. A competitor who has no organization, hence no overhead; no equipment, hence no equipment costs; perhaps no reputation, or one he may be glad to lose, is a severe handicap.

THE EFFECT ON THE PUBLIC

Millions of public money have been wasted through repairs, replacements, and delays due to poor workmanship, because of irresponsibility on the part of the contractor. Belief that price alone is to be considered because the city has its inspection and engineering forces to assure good workmanship, and a surety bond to assure the contractor's responsiblity and reimburse the city for all losses, is erroneous. Neither fully protects.

The Public Official's Problem—The public official's problem is to let the contract to a responsbile low bidder and see that it is completed according to plans and specifications. The usual system is to open all bids offered and then decide whether the low bidder is competent. If he is not, the official may then (1) reject all bids and readvertise, with the consequent delay and added cost, and risk having the same bidder low again; (2) award to an irresponsible bidder; or (3) award to a competent man at a higher price. The official's discretion will not be questioned by the courts if properly exercised, but the human element of error subjects him to the risk of what may or may not be unjust and injurious interference and criticism. The low bidder will bring pressure to bear to obtain the award, aided by the surety agents and sometimes by the banks; and enjoin the award to a higher bidder. Press and public seldom understand the technical reasons governing an award, and both may become harshly critical of the official's judgment and integrity; so much so, in fact, that he approaches a letting under a heavy strain, fearful of the incompetent low bidder and of the stand which he may have to take. The situation imposes an unfair and unnecessary stress, besides requiring an integrity, a stamina, and a discretion which all do not possess.

The Field Work.—With the work let to a competent, experienced, properly financed organization at a proper price, supervision is easy; the parts fit and operate together with little friction; material arrives as required; equipment is kept working; breakdowns are quickly repaired; energy and optimism pervade all. But with the incompetent, losing contractor, the engineer must alternately nurse and battle, his only ultimate recourse being to stop the work. If he interferes in its operation before the contractor has defaulted, the owner is in the technical position of a defaulter, and both the engineer and the owner would be at the contractor's mercy.

The Bond.—The surety bond guarantees that—barring escape on technicalities—the contract will be somehow completed within the contract price, but it is emphatically stated by a surety official[2] that a surety bond executed for a contractor does not of necessity or otherwise guarantee the sufficiency of the contractor's price, nor his experience, nor his financial responsibility . . . . nor that the contractor will not default or that he will do all that is called for in his contract."

The surety company's chief concern seems to be the contractor's ability to reimburse the surety company, the same official stating: "Seldom, if ever, are new and inexperienced contractors able to secure corporate suretyship unless they possess ample financial ability to offset what is lacking in the way of experience," so that "while an inexperienced contractor may not make a profit or may even sustain a loss, in most cases the only person to suffer is the contractor himself." But is this true?

Who Pays?—The bond does not reimburse the taxpayer for business and rental losses due to unfinished structures; losses of time; wear and tear on vehicles; maintenance of detours; replacement, repair, and maintenance costs caused by improper construction. Premium costs, except on paving, bridge work, and dredging, are reported as 1½ per cent on the amount of the contract price for twenty-four months protection. These premiums are paid by the people. When the underwriting standards are relaxed and loss results from bonding irresponsible contractors, the surety company does not pay the losses, but they are transmitted through their rates to the contractors and thence to the country as a whole.[3]

PREQUALIFICATION AS A METHOD OF DEALING WITH THE IRRESPONSIBLE CONTRACTOR

Prequalification is a means of placing contracting on a firmer business basis by establishing lists of contractors qualified to bid on work of various classes and

[1] *Constructor*, January, 1924, p. 52.

[2] Richard Deming, vice-president of the American Surety Company of New York, in a letter to E. J. Thomas, Memphis, Tennessee, October 30, 1926.

[3] See open letter by Edmund J. Donegan, General Counsel, Metropolitan Casualty Insurance Company of New York, November 29, 1926.

magnitudes. The lists should be prepared by boards, which base their decisions on evidence furnished by the applicants. To facilitate this, a Joint Conference on Construction Practices,[4] consisting of representatives from national organizations of state highway officials, architects, consulting, civil, and mechanical engineers, general contractors, highway exhibitors, and casualty and surety agents in 1925 issued forms for standard questionnaires, including an experience questionnaire, a plan and equipment questionnaire. and a financial statement. The use of these was recommended to elicit the information required to make up the classifications.

How Used.—It is proposed that once yearly the contractor file with the board copies of these questionnaires. Thereafter, no experience questionnaire would be required, except when transfer is requested. The financial statement might be required, twice or four times a year, or perhaps only currently with an award. An equipment questionnaire would be required with each bid because equipment varies with each job. How frequently transfers might be made and how short a time before a letting a new applicant might file his papers are questions upon which few guides exist. But it seems undesirable to obstruct transfers unnecessarily. New applicants must allow sufficient time before a letting for an investigation of their credentials.

Where Used.—Prequalification has been used principally on highway work. For over two years Wisconsin has registered and classified those who wish to bid, with satisfactory results. Iowa requires a new contractor to submit his qualifications at least five days before the letting. In Kentucky the plan and equipment questionnaire must be filed with every proposal submitted; the financial statement and experience questionnaire with the first proposal and every six months thereafter, or oftener if requested. Atlanta is reported to have adopted prequalification on public works costing over $5,000. A New Jersey law[5] requires prequalification on public works. The chief of the Bureau of Public Roads, U. S. Department of Agriculture, reports (April 20, 1929) that the Bureau has prequalified for about two years and found it satisfactory. A Philadelphia ordinance[6] proposes the filing of questionnaires not later than ninety-six hours prior to the opening of bids.

By Whom Advocated.—Prequalification was recommended by a joint committee of the Associated General Contractors and the American Association of State Highway Officials, Chicago, November 12, 1928; by the Philadelphia City Contract Committee appointed by the mayor of Philadelphia in 1928; by the Interdepartmental Committee of the same city, 1929; by a committee of the Philadelphia chapter of the American Society of Civil Engineers; and by numerous individual engineers and governmental officials.

OBJECTIONS TO PREQUALIFICATION

An objection heard is that the questionnaires are too complicated. Where good bookkeeping is practiced, this objection would not hold, but contractors who are lax in this respect would probably experience some difficulty. It would seem, however, that contractors should keep accurate books, for their clients' safety if not for their own.

Another objection is that prequalification may expose the contractor's private affairs to his detriment. But his banker's inquisition is not opposed on this ground. He should, of course, have assurance that only under exceptional circumstances would the information supplied by him be accessible to others than those officials who are required to pass upon it.

Will prequalification facilitate combines to restrict competition? No existing controls will be lost under prequalification. Contractors form great organizations, following the trend of the times; but it is questionable if they can ever close the field to small men, because the distribution of work and its character would probably render it uneconomical. Prequalification can neither retard nor accelerate this tendency. Contractors dare not combine in restraint of trade so long as public work may be done by day labor.

Will prequalification shut out the beginner and restrict the field to old and rich concerns? Most men must begin in a humble capacity with some responsible organization and there acquire training and experience for independent work. Under prequalification younger men would be welcomed in the lower classifications, their advance depending on themselves alone. An impartial body passing on the fitness of applicants protects not only the public but the men themselves, preventing the premature assumption of burdens which might crush them.

The classified lists probably should be made up by boards, which should inspire more confidence than individuals; and a contractor having additional evidence to present should be privileged to reopen a case in which an adverse decision has been rendered.

CONCLUSIONS

On private work, bids are requested only from those contractors believed to be responsible. The movement to control the irresponsible contractor on public works is gaining strength; and prequalification, an ancient and satisfactory restrictive method, seems the most practical means. It seems applicable to construction contracts, and no more subject to abuse than the existing system. Under a properly standardized system, it should benefit all connected with or affected by the construction industry.

Bureau of Contract Information

A Bureau of Contract Information has been incorporated under the laws of Delaware as a culmination of several years' activity on the part of the Associated General Contractors of America, to bring surety companies into line for the purpose of making it more difficult for incompetent and unreliable contractors to obtain contracts. Twenty-eight surety companies are represented in this bureau, which companies write about 80% of the surety bonds.

The purpose of this bureau is to obtain information on the past performance of every contractor. which information will be available to the participating company's agents when a contractor applies for a surety bond. It is hoped that this bureau will rid the contracting industry of that class of contractors which depend upon a bond to cover their inability to properly appraise a job; also that it will lower the premium rate; but especially it is hoped that the information obtained by the bureau will make it possible to differentiate between failures and losses which are the result of circumstances over

[4] 1150 Munsey Building, Washington, D. C.
[5] *Laws of New Jersey*, 1928, chap. 189, p. 358.
[6] Now before council.

which the contractor had no control and losses due to lack of ability and integrity.

It will probably be several years before sufficient information has been collected to give anything like full effectiveness to the bureau. Also, bonds are required on only about one-half of the construction work let; but if ultimately 50% of the contract work let can be controlled through such a bureau of contract information, it will undoubtedly have a beneficial effect upon the entire contracting industry.

Highway Work in 1929

A census of state highway departments completed recently by the American Road Builders Associaton, shows that 42 state departments estimate a total of 21,644 miles of roads to be constructed this year in their states. Returns received from all states except Connecticut and Nebraska indicate $744,266,000 available for maintenance and construction this year; this sum including federal aid, funds raised by gasoline taxes, motor vehicle registration and various other methods. Returns from 40 states show estimated county expenditures for this year of $405,150,000, which, added to the state funds, gives a grand total of $1,149,416,000, which is considered a conservative figure of the total money that will go into good roads during 1929 or the fiscal year 1929-1930. The estimate of the Bureau of Public Roads is $1,315,000,000.

The state of Iowa expects to pave with hard surface 750 miles of road each year in 1929, '30, and '31, making a total of 4,150 miles of paved roads, the state now having about 1,900 miles of such roads.

Kansas has a construction program of 1875 miles, including 800 miles of grading, 1000 miles of sand and gravel and 75 miles of hard surface.

New York state expected to add 700 miles of all types of roads this year and probably more than that in 1930.

Ohio expected to add 300 miles of hard-surface and gravel roads this year; Pennsylvania, 500 miles of hard surface; Texas, 800 miles of all types this year and probably the same amount during each of the next two years. West Virginia expects to add 360 miles of hard surface during each of the next three years; Wyoming, 390 miles of all types this year and 375 miles during each of the next two years; Michigan, 560 miles of all types this year, and 500 next year; Alabama, 1100 miles of all types this year; Kentucky, 382 miles of hard surface this year and more during each of the next two years; Illinois, 600 miles of hard surface; North Dakota, 1000 of all types annually in 1929, '30 and '31; Missouri, 1291 miles of all types this year and 917 next. Mississippi was the only state that had no funds nor estimate for construction this year.

The census shows that in 22 states all construction is by contract; 23 states employ more or less day labor when bids are too high, in emergency or on small projects; while convict labor is used on roads in Florida, Michigan and Virginia.

At least six states divide the gas tax between the state and the counties, Florida giving the counties four cents of her six cents tax, and Mississippi giving the counties three cents out of five.

New Mexico and Maine expect to complete bond issues this year; Mississippi anticipates an issue in 1930; Maryland and Iowa in 1931; the latter for $100,000,000; while Alabama and Georgia are desirous of issuing bonds, the latter state seeking $100,000,000.

Lime Rock Base for a Brick Road

Georgia claims to have laid the first pavement ever constructed on such a base. Lime rock coming into general use in Georgia and Florida. Method of construction described

By J. F. Coleman*

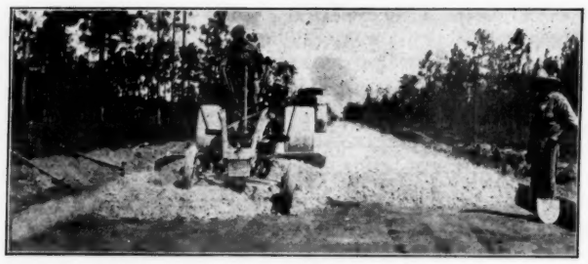
There is now being laid in South Georgia on State Route No. 38, Federal Route No. 84, a type of highway pavement which I believe can justly lay claim to the honor of being the only one of its kind in the world—a brick surface on a "lime-rock" base. Brick pavement is known everywhere, but this type of base is little known outside the states of Georgia and Florida, where its use is very common owing to its ready availability in local deposits and consequent economy in laying.

This type of paving suggested itself from the fact that satisfactory brick surfacing requires a rigid, non-yielding base, and lime-rock offers such a base at a lower cost, because of local deposits and economy of placing, than the types of base commonly employed; in addition to which, it is not so susceptible to temperature stresses.

The section of road selected for trial was 1.8 miles of an old gravel surface which had worn down to an average thickness of perhaps three inches. The work contemplated using as much of the gravel as possible where the existing section conformed sufficiently to the section and grades specified. The section called for 5 inches of compacted lime rock on top of the old gravel base, and a 6″x10″ concrete curb poured so as to unite as much as possible with the lime rock and gravel base and end flush with the top of brick. Regular paving brick was to be laid on top of the lime rock on a ¾-inch sand cushion.

The limestone known locally as "lime-rock" has had such a wide use as a road material and lends itself so readily to highway purposes that it deserves some discussion on its own account. It is classified texturally and chemically as a granular, highly fossiliferous, high-calcium limestone. It outcrops just below the 33rd parallel in middle south Georgia and runs in a narrow, jagged strip in a southwesterly direction for about eighty miles, where it ends in this state; but reappears in considerable quantity in northwestern

*Maintenance engineer, State Highway Board of Georgia.

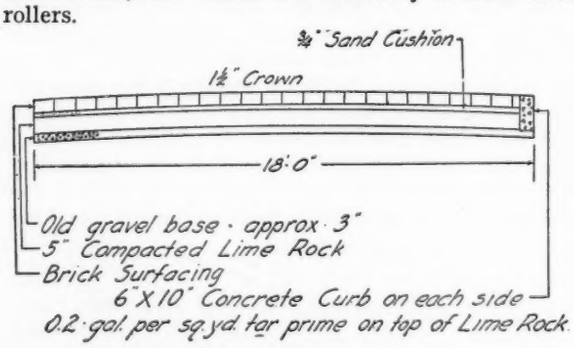


SPREADING LIME ROCK

Florida over an area roughly 150 by 50 miles, paralleling the Gulf of Mexico. It no doubt covers a much wider area than this; also there are quite a number of other argillaceous and calcareous deposits that are quite similar in texture and composition. However, the area described contains all the present known workable deposits of any great commercial value.

Its worth as a road material lies in its high calcium content, which often runs over 99% in $CaCO_3$, giving it a great cementing value; the other components being chiefly silica, iron and alumina. Geologically it is assigned to the Jackson age of the upper Eocene epoch. It varies in color from a cream-yellow to an almost white when mined, but will bleach out to a chalk white upon exposure to the air. It is soft and porous generally but with hard, semi-crystalline masses at the surface and promiscuously throughout the deposit. Layers of chert may occur, as does silicification of the surface rock. It faces up to quite a depth at points, there being one working face of over one hundred feet in the Ocala, Florida, deposit, while borings have given thicknesses up to four hundred feet. The pits are worked to the depth at which the water table is encountered.

Mining lime rock is all open pit work with power shovels—the over-burden is just stripped off and actual mining is begun. Sometimes the rock is so soft as to be taken off by the shovel, but usually it is blasted and fractured to make the shovel work easier. It is then hauled to a crusher and crushed to size required and loaded directly into railroad cars. Although it is usually of such soft powdery form as to make crushing only a matter of form, there are often masses of harder material—consolidation of limestone around fossil shells, etc.—which it is necessary to crush in the rollers.

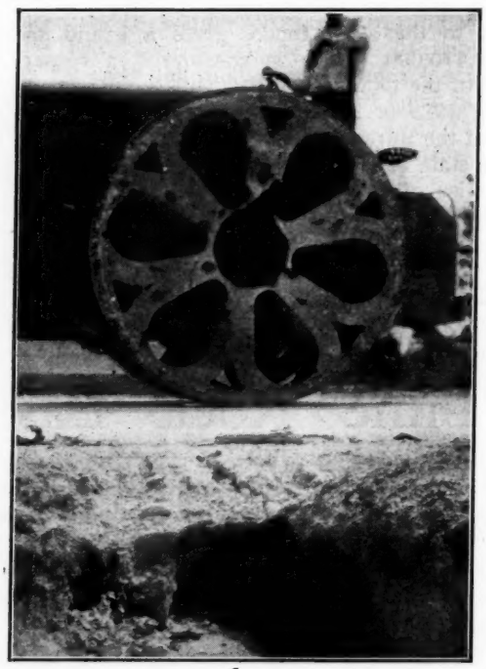

½" Sand Cushion
1½" Crown
18'-0"
Old gravel base - approx. 3"
5" Compacted Lime Rock
Brick Surfacing
6"X10" Concrete Curb on each side
0.2 gal. per sq.yd. tar prime on top of Lime Rock

BRICK SURFACE ON LIME ROCK BASE

Except for crushing, limerock comes out ready to be placed on the road, and may be placed as rapidly as transportation facilities permit, one mile a week of an eighteen-foot roadway of eight inches compacted thickness being a good average.

The subgrade is prepared much the same as if for concrete, by sprinkling and rolling until well consolidated. Form boards are placed conforming to level hubs at the sides, allowing for about 20% compaction under roller. Spreading is either by hand, or by road machine in connection with hand work. The rock is dumped directly on to subgrade and spread uniformly between form boards, all large masses of flint or other undesirable material being thrown out. Then, if at the proper stage of moisture, it is rolled with a three-wheeled power roller of ten-ton capacity until thoroughly compacted; doubling back each day over one half of the previous day's work, to insure two days of continuous rolling of the entire surface.

The surface is very rough after the initial rolling, owing to the lumpy condition of the rock tending to segregate and form pockets. It is immediately scarified to a depth depending on roughness and presence and size of lumps, machined with a minimum 3000-lb. road machine and re-rolled, this process continuing until a section is obtained conforming to requirements of the specifications. It may be necessary to sprinkle



DEMONSTRATION OF STRENGTH OF LIME-ROCK BASE AFTER SETTING

the subgrade before placing, if rock and subgrade are dry and weather hot; also it is often required to water the rock to soften it and insure a better bond and denser mass under roller. To obtain a satisfactory bond the rock *must* be moist throughout.

[For description of the Florida method of construction, see "Highways of Hillsboro County, Fla.," in *Public Works* for January, 1928.—Editor.]

Traffic can use the road during the whole operation of placing if necessary, and after the first shaping it is turned over to traffic for a period of four weeks for curing and final compaction. During this period the rock will cure out from a cream yellow to a chalk white and become smooth and dense, resembling concrete on the surface. It shows a tendency to pot out in small holes, and possibly a few larger areas will need replacing as traffic shows up the weak places.

FINISHED BRICK SURFACE ON LIMEROCK BASE

It has been found that the higher the calcium content the more it lends itself to working requirements and the greater initial stability—it is less liable to soften under heavy rains, etc.; but on the other hand, it cures out faster and is more inclined to pot out and need patching before final curing has taken place through the full thickness.

Actual placing begins nearest point of unloading and continues away from it so that the rock placed may have the benefit of the heavy hauling of the remainder of the material. This subjects it to a traffic stress heavy in both volume and unit loads and is one of the most beneficial features in connection with its adaptability for road uses.

After the initial shaping and sometimes before the curing period ends, it may require scarifying lightly and re-shaping in places if it fails to hold its shape. When thoroughly cured it is given a final heavy blading to remove all loose material, foreign matter and slight roughness from the surface and large holes are patched with rock and rolled far enough in advance to allow curing. It is then swept with a road broom and covered with about 0.2 gallon per square yard of "prime" (a tar product of 80 to 120 viscosity and specific gravity of 0.93 to 0.97), which is applied hot by a self-propelled pressure distributor. This prime is allowed to penetrate anywhere from twelve hours to several days, depending on how rapidly it is absorbed, and then covered with a light coat of sand to take up the surplus and again turned over to traffic for another period of two to four weeks, so that all volatile oils in the prime may escape and traffic may thoroughly iron it in. It is a known fact that the penetration of the prime coat is greater where the traffic tracks are heaviest, except when a smooth condition known as "glaze" appears under traffic wheels, which must be machined off before application to get good penetration.

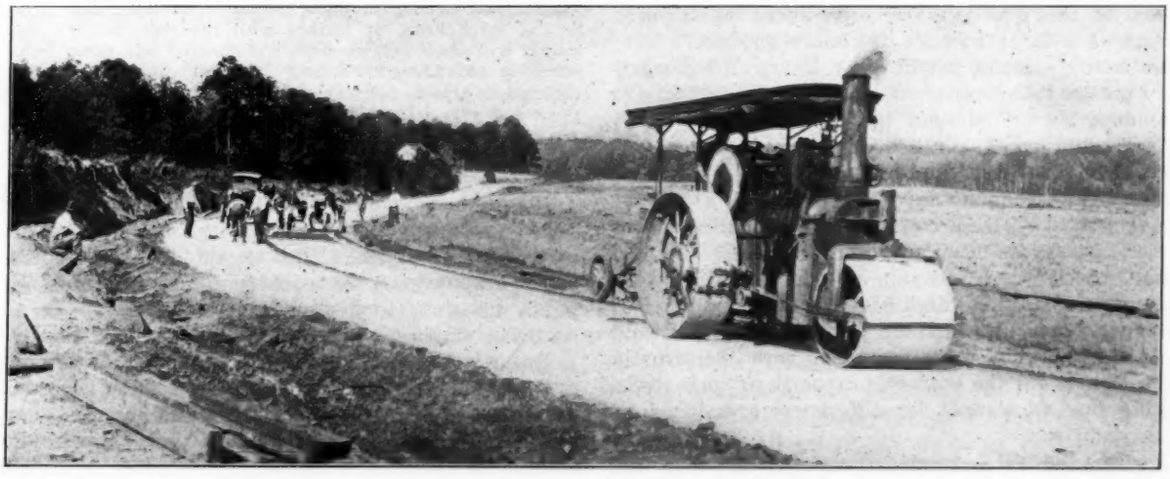
When this ironing out period is past, all small pot holes, etc., are caught up with a mixture of asphalt and fine slag, which is rolled in to conform to the general surface and the surface is again swept.

The base is then ready for whatever type of surface is specified. The more common one is laid as follows: About 0.4 gallon of 200 penetration asphalt is applied by a distributor at a temperature of 325 to 375 F. and covered immediately with about 40 lbs. of No. 4 slag screenings (¾ to ¼ inch), which has been stock piled at close intervals along the road. It is then rolled with a ten-ton roller and immediately turned over to traffic a finished highway.

Numerous construction details are of necessity left out of this discussion but the most important features have been touched upon.

In laying brick on such a foundation the standard method is followed—a sand cushion approximating ¾ inch is struck off by templet and lightly rolled and the brick placed thereon and rolled, after which they are flushed with an asphalt filler which is squeegeed into the joints and the whole covered with sand.

POURING CONCRETE CURB



ROLLING WEARING SURFACE OF LIMEROCK

Closest engineering supervision is had throughout the whole operation. Blue tops for the base are driven at 50 ft. intervals on tangent and 25 ft. on both vertical and horizontal curves. Before acceptance of the base it is checked with a templet of the cross section, and a ten-foot straight edge laid parallel to the center line; in addition to which a 50 or 100 ft. cord is stretched tautly longitudinally along the surface to reveal all long waves and deviations missed by the straight edge, looking to their elimination. Only the minutest variations from the specifications are allowed. There is always an inspector at the dump to check form boards and subgrade and supervise watering (which is very important), and the resident engineer assists in this as well as inspecting rolling, scarifying, blading, etc.

Limerock base offers the advantages of allowing use by traffic at all times except when thoroughly saturated, when it becomes too soft to support traffic, but ordinarily this is for only short distances which can be bridged or crosslaid with boards. It also permits of finishing the surface with a road machine which has a long wheelbase and tends to eliminate rises and depressions that would not be caught by the straight edge, also making the straight edge work easier. Limerock can also be placed at a much faster rate than the usual base materials. It permits of being reworked extensively over a considerable period, if found desirable under the heavy traffic in its initial stage.

However, it is very sensitive to moisture, and frequent rains will not only prevent placing but seriously retard curing. Plenty of sunshine is requisite to best results, which peculiarity is especially suited to the latitude in which it is found.

The unit of bidding is the square yard, and prices in place vary around $1.20 for an eight-inch depth, depending on freight, truck haul and other local conditions. The prime and surfacing are usually bid as separate items.

Limerock properly laid makes an exceptionally smooth riding road and has the appearance of a bituminous macadam after treatment.

What Traffic Will Low-Grade Roads Bear?

One of the questions recently asked by PUBLIC WORKS of a large number of county engineers was: "How many vehicles per day can be carried economically on the following types of surfaces, according to your experience?" Under this question were listed the following types: Graded earth, sand-clay or top-soil, gravel and macadam, surface treated roads, and bituminous macadam. Several hundred replies were received, most of them covering only the three lower types of surfaces. Evidently relatively few had had actual experience with maximum traffic conditions on bituminous macadam and higher-grade roads. For the other types, the answers agreed quite well, and it is interesting to compare them with the usually given figures for the economic capacity of such roads, making due allowances for differences occasioned by local conditions.

For graded earth roads, a capacity between 100 and 300 vehicles per day was given by 45% of the engineers; 29% rated them as having a capacity of less than 100 vehicles per day; and less than 10% stated that their experience indicated that such roads would bear a traffic of over 500 vehicles per day. The weighted average of the answers places the capacity of earth roads at about 220 vehicles per day.

There was a greater diversity of opinion in regard to sand-clay and top-soil, due, no doubt, to important local differences in materials and methods of construction. The bulk of the answers varied between 150 and 550 vehicles per day, averaging quite uniformly 15% of the answers for each variation of 100 vehicles within these limits, and this group accounted for 80% of the total replies received. The weighted average of answers indicated the common experience showed that an average of 360 vehicles per day could be carried on such roads.

Nearly as great diversity of opinion was found in regard to gravel and water-bound macadam roads, and local difference of material was probably a factor here also. Replies ranged from 200 to 2000 vehicles per day, with the majority of the replies ranging between 500 and 1000. The weighted average of this group is almost exactly 800 vehicles per day.

Estimates of capacity of surface-treated roads ranged quite uniformly between 1000 and 2000 vehicles per day as the economic limit. In the case of bituminous macadam, there was a considerable variation, ranging from 1000 to as high as 5000 vehicles per day, but most of the statements ran from 1500 to 2000.

Some Objectionable Features of Snow Removal

The "Wisconsin Highway Builder" quotes an official of the Wisconsin State Highway Department as saying:

> In checking up the cost of snow removal in the division this spring, we find many items that are not generally thought of as a part of the cost of this work, but which are directly traceable to this activity. The more serious of these items are broken guard rails, mutilated driving signs, gravel plowed off of the roadway into ditches and swamps, and last, but not by any means least, the loss of the use of our roads this spring because of an unusually bad siege of "frost boils" caused by deep frost where roads were plowed and exposed to unusually cold weather of the past season. On our gravel roads, we find thousands of yards of gravel plowed off the roadway where it cannot be salvaged. In some cases where rotary snow plows were used, the gravel was first plowed into ridges on the shoulder of the road and then spread to the fence lines, or further with the rotaries. We have always had some loss of surfacing material but never before anything so serious as during the past season. It is found that oiled gravel surfaces suffered about the same as the untreated gravels and it would seem that, unless some way can be found to prevent this loss in the future, gravel roads will not last long enough to pay for building them in a snow-removal country.

It will be noted that this official does not suggest the abandonment of the new policy of keeping highways open in winter. With an automobile for almost every taxpayer in the country, inability to use the roads for days and weeks—perhaps months in the northern states—every year would not be tolerated.

But what he says should be considered seriously and methods devised for eliminating these objectionable results of snow removal. Breaking of guard rails and signs is surely avoidable, although understandable when snow fighting is carried on during the height of a blinding storm. Removal of gravel,

and even to some extent frost boils, can be prevented by a policy of leaving an inch or two of snow on the road; at least, if the gravel surface is put in good shape for the winter before snow falls.

Cast Iron Pipe Joints

Six types of joints for cast-iron pipe discussed, and methods of making each of them described in detail

Materials other than lead for making joints in cast-iron pipe was the subject of a paper by W. C. Mabee, chief engineer of the Indianapolis, Indiana, Water Co., before the Indiana section of the American Water Works Association.

He classified cast-iron pipe joints as of six types: 1, poured lead joints and pre-calked lead joints; 2, self-calking sulphur base compounds for joints, such as "leadite," "hydro-tite," etc.; 3, cement packed joints; 4, rubber packed joints, such as "victaulic" pipe couplings and Dresser sleeves; 5, bolted metal contact pipe, such as Universal pipe, and 6, flanged and bolted joints. His discussion of the six types is abstracted in the following:

1—Economically, lead is perhaps the most expensive type of joint, although it may be contended that it has advantages which justify the additional cost. Precalked lead pipe and fittings are now available, ranging in size from ¼ inch to 8 inches diameter, in standard lengths, and seem to be supplying a definite demand.

2—Leadite has been used as a jointing material for thirty years, hydro-tite for a less period, and a similar material called metallium has been used. These materials are made with a sulphur base. Joints made with them require no calking and no bell-holes, and the makers claim they have all the advantages of lead, with the addition of a substantial saving in cost of installation. Both leadite and hydro-tite are being used extensively as a jointing material. Some cities are using both lead and leadite; and a few give the contractors the option of using either jointing material.

3—Ordinary Portland cement has been used on the Pacific coast as a jointing material for cast-iron pipe since 1886, but did not come into general use until about 1911, and today, while used extensively by many large cities of the west and southwest, apparently has not been used at all in the east. (See article "Cement for Water Pipe," in the issue of PUBLIC WORKS for August, 1929, and "Moving a Cement-Jointed Water Main" in the present issue.)

4—Under rubber packed joints, the author describes the victaulic pipe coupling now being produced in this country after having six or seven years' use in England. It consists of two metal half-housings, an inner ring of a special rubber composition, and two bolts. The manufacturer claims that it is automatically leak-proof and can be installed faster and at less cost than any other type of coupling. Pipe made for these couplings is cast with a shoulder on each end and there is no overlapping. The couplings are of malleable iron. The rubber gasket or ring is so shaped that internal pressure automatically increases the seal. Mr. Mabee stated that he learned upon investigation that this joint is effective in locations where a high degree of flexibility, expansibility, or contraction is desired. The flexibility is especially desirable in pipe laid along or across railroad tracks, where the vibration of trains tends to loosen the lead in bell and spigot joints.

The makers of the rubber gaskets for victaulic couplings express the opinion that the gaskets will live as long as the pipe on which they are installed. They have samples of the same rubber compound which have been buried in a gas service for 49 years and the rubber is still alive and resilient.

The Dresser sleeve has, the author says, supplied a demand for this type of joint for many years.

5—Universal pipe, used successfully for many years, requires no packing, no calking and no bell-holes. The ends of the pipe are machined at slightly different tapers, which permits a high degree of flexibility. The absence of all jointing material and the flexibility of the pipe joints commend its use in many localities and under trying conditions.

6—Because of the rigidity of flanged joints, they are inapplicable for ordinary water supply systems, except inside pumping plants.

Of these materials, other than lead, the Indianapolis Water Company has apparently used only leadite. Since 1924 it has laid over 100 miles of 6-inch to 24-inch cast-iron pipe with this material with perfect satisfaction; although it still prefers lead under certain conditions, among these being where running water is flowing along the pipe; at pumping stations or other places where it is desirable to "set up" the joints at intervals, when they are sprung by the pulsation of reciprocating machinery, etc.; the joints and the yarn used therein must be entirely free from grease or oil where leadite is used; there seems to be more danger of leaks at the pouring gate, due to foreign matter in the leadite, than with lead joints; much greater care must be exercised in melting leadite to exactly the right temperature than is the case with lead; and rain interferes more seriously with running joints with leadite than with lead, since the flax packing must not be wet when leadite is poured. The company has found much saving in time by the use of leadite, since excavations for bell holes are eliminated, calking is not required, and several hundred feet of leadite joints can be laid out ahead of the men pouring the joints. On a test, the construction superintendent laid 23 lengths of 8-inch pipe and 23 joints with leadite in 27 minutes. Seeping joints and even slight leaks or small, spurting streams automatically seal themselves without any attention; while a leaky joint can be repaired by cutting out the leadite back to the lock or groove and filling the space with lead wool calked into the opening.

MAKING JOINTS

In making joints with leadite or hydro-tite, the same precautions are necessary as for making lead joints, such as aligning the pipe, cleaning, etc.; and in addition, all oil or grease must be removed and the pipe thoroughly cleaned with a wire brush, removing all gloss, scale and foreign matter where it

comes in contact with the joint material. Braided hemp is especially adapted to this type of joint, and should be driven tightly into the bell, permitting the leadite or hydro-tite to occupy 2½ inches of depth. It is important that the pouring gate be of metal and built up 6 or 8 inches above the top of the bell, in order to get ample lead on top of the joint, and that the joint runner or hemp and pouring gate be thoroughly clayed to prevent the joint material from escaping during the pour. Special care is necessary in pouring to avoid air pockets, which is accomplished by pouring evenly and slowly so that the air escapes as the joint is filled.

For cement joints, the jute must be free from oil or grease and a thin layer calked into the bell as with lead. A small quantity of Portland cement is slightly moistened, so that when gripped in the hand it will hold the form of the grip, but will crumble when dropped 12 inches; 13 to 14 pounds of cement to one pound of water generally meets this condition. The cement is then tamped into place by hand until the bell is about half full, a canvas having been spread under the joint to catch the excess cement. It is then calked with heavier blows until the cement is thoroughly packed in the back of the socket. This process is continued until the bell is packed solid.

The joint should at once be covered with earth to protect it from the sun and air and allowed to stand 48 hours before being subjected to pressure.

When installing victaulic couplings, care must be taken to see that the rings are centered over the pipe ends and the couplings placed properly in the grooves at the ends of the pipe. The assembly is facilitated by coating the ends of the pipe and the chamber of the housing with a lubricant, such as graphite paste. The full gap is to be allowed for every other joint, with the pipe ends butting at the intermediate joints, to take care of expansion and contraction.

In laying Universal pipe, the ends must be cleaned thoroughly and the bolts pulled up evenly to prevent undue strain on the flanges or injury to the pipe ends.

Pathogenic Bacteria in Refuse

A number of experiments have been carried on by J. Kister, according to the "Bulletin of Hygiene," in which he endeavored to determine the duration of vitality of typhoid and paratyphoid bacilli in refuse. Small pieces of linen, of cotton wool, and of paper were soaked in cultures of these bacilli and buried in kitchen refuse, room sweepings and in ashes. Wires were attached to these pieces of cloth or paper before they were buried, so that they could be removed readily for inspection.

Typhoid bacilli were found in kitchen refuse up to 14 days but not after 16 days. They could not be found in room sweepings after 30 days, but were found in ashes even after 130 days. Paratyphoid bacilli were capable of growth in kitchen refuse after 20 days, but not after 24 days, and could be found in room sweepings even after 50 days, and in ashes after 130 days. Dysentery bacilli could not be found in any of the three classes of refuse after the tenth day.

In order to learn something about the dissemination of these germs, kitchen refuse, such as potatoes and greens, were soaked in typhoid cultures and placed in a glass vessel. Flies were introduced in these vessels for a short time and typhoid bacilli were almost always found upon their legs and less frequently in their intestines.

The conclusion from this, of course, is that no bed clothing or personal clothing which has been used by typhoid patients should be thrown out with the rubbish, but such should always be either burned or thoroughly disinfected.

Jacking Sewer Under Railroad

An unusually difficult job in sewer construction was performed by the Haverty Company of Los Angeles, Calif., in laying 1400 feet of 12-inch sewer between the Los Angeles County Farm and the Metropolitan outfall sewer. The land where this sewer was laid consists of about 10 feet of silt and clay underlaid with quicksand; and as it was necessary to lay the sewer 11 to 13 feet below the surface, all of the laying operations were carried on in quicksand below water level.

A dragline was used for excavating to the quicksand, the trench being dug 14 feet wide on top without sheeting. At quicksand level, sheet piling consisting of 2″x8″ tongue and groove planks, surfaced on four sides, was driven to one foot below grade by means of air hammers, making comparatively watertight sides to the bottom part of the trench. A well point system was used for drawing the water down in the trench below the sewer grade, pumping being done with Domestic diaphragm pumps. Some trouble was encountered with the well points due to the fact that layers of fine clay and silt are scattered throughout the quicksand, some of which tended to form pockets into which the water would not flow, while well points driven into such fine material would not admit the ground water. In such places the points were driven deeper or were withdrawn and driven in a new location a few feet distant. When the water had been drawn down, the rest of the trench was easily excavated by hand and the 12-inch sewer pipe was laid on cradles 16 inches wide made of pieces of 2-inch redwood plank. After the sewer had been laid, the trench was filled by hand up to a point above the top of the sewer and the rest of the filling was done by bulldozers driven by tractors.

The line crossed under the track of the Union Pacific Railway, which was laid on an embankment elevating the rails to 18 feet above the flow line of the sewer. The railroad had made a rule that before any excavating could be done under their track, they would drive piles and on them place heavy bridge timbers for supporting the track over the excavation, the cost of the work being charged to the contractor. In order to avoid the cost of this work, Haverty and Co. decided to try jacking a large pipe or culvert under the track and laying the sewer in this. Open trench was carried up to the embankment on both sides with vertical faces, which faces were 30 feet apart, through which distance the culvert was jacked. Thirty-inch Armco corrugated culvert pipe in two lengths, one 14 feet long and the other 16 feet, was used for this purpose. A rim of wood was built around the rear end of the section to prevent the metal from being buckled when the force was applied to it with the jack. The 14-foot pipe was leveled up on a wooden cradle and a 50-ton ratchet jack was used for forcing it through.

Two men worked inside the pipe, one cutting away the material in front of it, and the other moving the material back towards the rear. The man excavating took particular care not to remove any material outside of the line of the pipe, so that there should be no settlement of the soil around the pipe afterward. The pipe was pushed forward at the rate of about a foot an hour; a spirit level was kept on the pipe most of the time to insure its keeping on the desired grade, and the culvert was only one inch off grade when it emerged at the other end.

After the 14-foot length of pipe had been pushed in, the 16-foot length was fastened to the rear end of it and the operation continued. When this 30-inch pipe had been forced the full length under the track, the 12-inch sewer pipe was laid inside it, imbedded in a cradle of concrete, and the remaining overhead space was filled solidly.

The contracting company figures that it saved $1,030 by carrying the sewer through in this way instead of in open cut; but does not recommend this plan where there is no rail or highway traffic to maintain, as it is more expensive than making an open cut or a timbered tunnel. There was a saving in this instance only as compared to the cost of putting in the bearing piles, bridge timbers, etc., to support the railway tracks, which would have been about $1,200. The actual cost of the work was $150 for 30 feet of 30-inch culvert pipe, and $250 for labor and the rental of equipment.

Industrial Wastes in Sewage*

What classes of wastes should be excluded from sewers and why. Minimizing objectionable effects

The effect of industrial wastes upon a municipal sewerage system depends upon their relative volumes and analyses as compared with the domestic sewage into which they discharge, and to some extent upon the time elapsing before the wastes reach the sewage treatment plant. Ordinary municipal sewage has a diluting and neutralizing effect on acid and other industrial wastes, and as a consequence it is often practicable to treat sewage containing large quantities of such wastes by the usual bacterial methods.

Results indicate that industrial wastes should not be admitted to sewers, first, if they contain substances which will adhere to the walls or form deposits; second, if they contain inflammable substances; third, if they contain steam or very hot liquids; fourth, if they contain acids which will injure the material of the sewer; or fifth, if they contain substances which will seriously interefere with the operation of sewage treatment works.

The first class includes wastes which contain warm fat and grease which, upon meeting the cooler sewage, solidify on the walls of the sewer; such as wool scourings, wastes from soap factories, packing houses, laundries, etc. This class also includes wastes from wire mills and tanneries which may react with other ingredients in sewage and cause deposits. Grease-forming wastes should be carried through grease traps at the plant so as to remove a large part of the grease and at the same time lower the temperature of the waste. Objectionable effects of acid wastes which are discharged in considerable quantities at intervals may sometimes be avoided by holding them in tanks and discharging them gradually or in proportion to the flow and strength of the sewage.

Inflammable wastes include those from garages, shops, power houses, etc., where crude oil or its various by-products such as gasoline, kerosene, etc., find their way into the sewer. Most of the explosions of so called sewer gas can be traced to the presence in the sewers of some of these inflammable wastes. Besides their danger to the sewer system, they prevent proper bacterial action at the filter plant, clog the nozzles and filters, and are detrimental to fish life when discharged into a stream.

Steam or very hot liquids are injurious to sewers and interfere with biological processes at treatment plants. Under this head come condenser water, wastes from laundries, gas houses, etc.

Of the wastes injurious to sewer materials, the most common are those containing sulphides, such as those from iron works and paper mills; these sulphides tending to form hydrogen sulphide, which causes disintegration of concrete surfaces in manholes, sewers and sewage treatment structures. Such effect is especially probable in the case of pressure lines or inverted siphons, sewers that are badly ventilated, or on long flat grades where sewage becomes stale before reaching the treatment plant. Also, the giving off of sulphurated hydrogen is very obnoxious, and even where sewers are well ventilated through manholes, the odors may give cause of complaint. Such condition may sometimes be prevented by pre-chlorination of the sewage.

Whether there will be interference with the operation of the sewage disposal works may be determined largly by the relative volume and strength of the waste as compared to those of the domestic sewage receiving it. Some wastes, like packing house waste, by increasing the strength of the sewage reduce the retention time necessary for sedimentation. Others, like wool scouring waste, on account of the large amount of finely divided solids in suspension, materially increase the time necessary for the required reduction of solids. For sedimentation, iron salts work best under a retention time of about one hour, while creamery wastes seem to require at least 48 hours and some results indicate a longer period. Most authorities agree that for strictly domestic sewage (that is, combined wastes from kitchen sinks, laundry tubs, bathtubs and water closets), the proper retention period is about two hours. As a result, the composition of sewage to be treated should be studied in determining the time of retention in the sedimentation chamber. Where the wastes are such as to add appreciably to the time which would be required for proper sedimentation of the sewage containing them, it is probably better that this additional retention period be obtained by tanks at the industrial plant of sufficient capacity so that, if their effluents be combined with the domestic sewage, the proper sedimentation may be obtained in the two-hour period.

Some wastes have serious effects other than those upon sedimentation. Paper mill waste, for instance, offers serious difficulties in sewage treatment on account of its antiseptic nature. Some acid wastes,

*Abstract of an article before the 4th Annual Missouri Water & Sewage Conference, by George S. Russell, consulting engineer, Springfield, Mo.

like mine drainage, those from wire drawing plants and tanneries, exert an inhibiting action upon bacteria and cause considerable trouble in sludge digestion. Some, like creamery wastes, give an acid sludge which increases the tendency to foaming and gives rise to much bad odor. These actions may be prevented to a great extent by the addition of lime in the sedimentation tank. Wastes which carry a large percentage of fat are resistant to bacterial action and thus interfere with the work of the filters, while the fats also diminish the value of the sludge as a fertilizer. If the fats are not already removed or greatly reduced by grease traps at the plants, skimming tanks at the sewage treatment plant should be provided for removing them.

In discussing this paper, F. M. Veatch stated that not all trade wastes were harmful; several investigators have attributed the exceptionally good results obtained at the activated sludge plant at Lodi, California, to the finely divided carbon waste discharged into the sewers from a lamp black plant. Recently residual chlorine was found at the sewage treatment plant at Independence, Mo., although no chlorine had been added intentionally to the sewer, this having been traced to a bleaching solution used by a laundry and discharged into the sewer. Other wastes, notably iron salts, when not in too great concentration, aid sedimentation materially by coagulating the solids into masses which settle readily.

Albion Improves Sewage Treatment Plant

The taxpayers of the village of Albion, N. Y., recently voted to issue $50,000 in bonds for making repairs, additions and alterations to the sewage treatment plant of the village, which was built in 1915. These changes include converting the contact beds into sprinkling filters and installing air-lift pumps to raise the sewage from the settling tanks to the dosing tank. The action taken is in line with recommendations made by the State Department of Health and will relieve the serious pollution of Sandy creek, into which the sewage from the village is discharged.

State Cooperation in Studies of Dairy Waste

The boards of health of Wisconsin, Iowa, and Minnesota, have entered into an agreement for experimental studies concerning methods of preventing stream pollution by dairy waste. Under this agreement, Wisconsin is to continue experimenting in disposal of creamery and condensary wastes; Minnesota will study cheese factory waste; while Iowa will devote her experiments to waste from butter making and receiving stations.

By thus dividing the problem among the three states, instead of each state endeavoring to work out methods for treating all kinds of daily wastes, and thus duplicating efforts, it is hoped that the cost of the work will be reduced for each of the states and at the same time development of satisfactory methods may be arrived at more quickly. L. F. Warrick, state sanitary engineer of Wisconsin, states that promising results have already been obtained in that state, in demonstrations under actual dairy plant operating conditions at De Forest. These tests, which are being continued, indicate that milk waste can be rendered unobjectionable for discharge into a water course by treatment on trickling filters of crushed rock.

Comprehensive Planning of Utilitarian Street Lighting

Includes standardizing and systematizing equipment, which should be flexible to allow for future expansion. Utilitarian lighting covers much more territory than ornamental

By J. F. Morton*

Utilitarian street lighting has failed to keep pace with the standard of illumination set by ornamental installations, most utilitarian installations consisting of various types of lighting units, both new and obsolete. This condition is due chiefly to lack of attention given such installations by the public, and of any comprehensive planning of this type of lighting. Such condition is unnecessary, however, for many new developments in street lighting equipment are available to progressive cities.

A well planned utilitarian lighting system should not only satisfy present demands, but should be flexible enough to keep pace with the future expansion of the community which it serves without becoming inefficient.

A recent survey made of a typical city showed that the lighting of approximately 85% of the total street mileage came under the utilitarian class and only 15% under the ornamental lighting class. It would appear, therefore, that considerably more attention should be given to the former class of street lighting.

The keynote of any comprehensively planned lighting system should be standardizing and systematizing By this the stock of repair parts and equipment necessary to be kept on hand can be reduced to a minimum, and indiscriminate installations of different types of equipment will be eliminated entirely.

The first step in making a comprehensive layout should be decision as to what type of electrical circuit or circuits can be used to advantage. They should be of sufficient capacity to accommodate any increase in the lamp size which future demands may necessitate.

Next, the city should standardize on a specific type or types of streethoods to be used throughout its system. The streethood selected should be properly insulated for the circuits on which it is to be used; be of pleasing and sturdy design, and light in weight, with all exposed parts covered with a durable finish; serviced and relamped easily; adaptable for both reflector and skirt with glassware; dust proof, bug proof

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and weather proof when equipped with enclosing glassware; and adaptable for standard fittings.

Two types must be considered, one to be used on multiple and series circuits below 2500 volts, the other on series circuits above 2500 volts. If for the former, the streethood should have its basic part a cast-iron canopy housing an adjustable socket support, suited for both multiple or series sockets. The canopy should be so arranged as to take either a reflector ring and reflector or a skirt and enclosing glassware, as the installation may require. By interchanging this equipment, the unit can be changed from the simplest to the highest type of streethood. The skirt should be equipped with such features as removable glassware holder and toggle catch for holding the glassware in place.

For the high voltage series circuit, the streethood should have a porcelain head housing the socket, and be adaptable for either reflector or skirt and glassware. The head should be of dry process porcelain for use on circuits below 6000 volts and wet process porcelain on circuits above 6000 volts.

The means of mounting the fixture cannot be standardized to the extent of the streethood, as each separate location offers a problem which cannot be covered by one line of mounting equipment. However, the planner can insist that all of the supporting equipment have a standard fitting so as to fit the streethood direct and eliminate the use of reducing bushings; and so far as possible, all parts of the mounting should be interchangeable.

Having decided upon the circuit and a standard type streethood, the territory adaptable for utilitarian lighting should be zoned, and all the streets therein should be classified and recommendations made for each class. Ordinarily the streets are divided into four separate classes: 1, Minor traffic streets; 2, minor residential streets; 3, warehouse districts; 4, alleys. This classification does not include streets for which ornamental units are to be provided, but in many cases utilitarian lighting is used temporarily until the municipality is in a position to install the more expensive ornamental units.

The following recommendation for each type of street is made as general as possible, to allow for the varying conditions arising in each different installation.

Minor traffic streets should always be well and uniformly lighted so as to facilitate the movement of traffic with the least danger of accidents. In minor residential streets the appearance as well as the efficiency of the lighting unit is of chief importance, for which reason ornamental installations are very prevalent, especially on major residential streets and to some extent on minor residential streets. However, the efficiency of the unit should not be overlooked, as sufficient illumination should be furnished to protect pedestrians and children while crossing the street after dark.

Warehouse districts and alleys are lighted chiefly for protection against violence and burglary and therefore the simplest type of unit can be used.

For each of these classes the supporting equipment should be determined by prevailing conditions. The type of lighting unit should be determined by the circuit; either unit with cast iron head or porcelain head, skirt and glassware holder should be used for the first two classifications, and same with radial wave reflector instead of skirt and glassware holder for the last two classifications.

The lamps used should be 4000 to 6000-lumen (300 to 500 watts) for the first class, and 2500 to 4000-lumen for the other three classes.

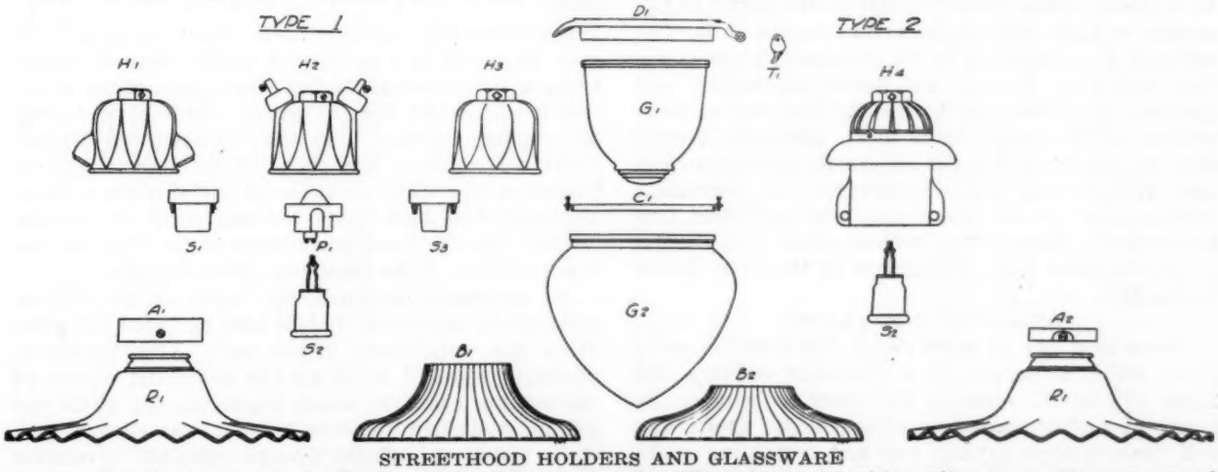
The glassware for the first class should be asymmetric refractor and enclosing globe and either asymmetric refractor or globe for the second class.

In arrangement of the lighting units, these should be staggered if convenient mounting permits in class 1, and on one side of the street only in the other three classes.

For spacing, approximately 120 feet is recommended for class 1, approximately 150 feet for class 2, and 180 to 250 feet for classes 3 and 4.

The mounting height recommended is 18 to 25 feet for class 1, 20 feet for class 2, and 20 to 25 for classes 3 and 4.

The average horizontal illumination for class 1 should be 0.2 to 0.3 foot-candles, with a uniformity factor (ratio of minimum to maximum illumination) of 0.60; should be 0.1 to 0.12 foot-candles, with a uniformity factor of 0.25 for class 2; and should be



STREETHOOD HOLDERS AND GLASSWARE

Type 1.—The three cast iron heads (H1) (H2) (H3) arranged for different types of wiring will accommodate any one of sockets (S1) (S2 P1) (S3). To form the simplest type of unit either (A1 R1) or (B1) can be attached. If a more efficient unit is desired any one of the following combinations of glassware and holders, (T1, D1, G1), (T1, D1, C1, G2) or (T1, D1, G1, C1, G2) can be added.

Type 2.—The porcelain head (H4) accommodates socket (S2). To form the simplest type of unit, either (A2 R1) or (B2) can be attached. If a more efficient unit is desired any of the following combinations of glassware and holders (T1, D1, G1), (T1, D1, C1, G2) or (T1, D1, G1, C1, G2) can be added.

0.8 to 0.12 foot-candles, with a uniformity factor of 0.30 for classes 3 and 4.

If the equipment recommended be adopted as standard, it will be possible to start with the smallest lamp on the alley or warehouse streets, and improve the lighting step by step as the demand for light increases. At first it will be necessary only to increase the size of the lamps. After the lamp size is as large as it is permissible to burn a bare lamp, the radial wave reflector and holding ring may be replaced by skirt and globe while using the same streethood head and supporting equipment. Then the lamp size can be further increased; and as a final improvement, a refractor can be added to the lighting unit. This provides a very flexible lighting system.

New Sewerage Plans for Missouri Cities

The State Board of Health of Missouri has approved plans for a sewage treatment plant at Vandalia which, if constructed, will be the first municipal plant of the activated sludge type in that state. It has also approved plans for the construction of a sewage treatment plant at Eldon, and for a sewer system and sewage treatment plant at Owensville. It has also approved plans and specifications for improving the water works system at New Haven.

Mixed-In-Place Roads in Michigan

What is said to be the first mixed-in-place road in Michigan has been built by Gratiot County. In surfacing this road, it was covered with about 3 inches of gravel on top of the original surface, and this with half-gallon per square yard of No. 5 Standard road oil. The oil was then worked into the gravel by means of a disk harrow and a road grader. Another half-gallon per square yard was then applied and mixed as before, and following this a third application, each being thoroughly worked into the gravel. The road was then disked and scraped. Before being applied, the oil was heated to about 120 degrees Fahrenheit in the Etnyre distributor by which it was applied.

Odor Control at the Macon Sewage Plant

By W. Scott Johnson[1] and Herbert Bosch[2]

A sewage treatment plant of modern type, if designed, constructed, maintained and operated in perfect accordance with correct principles and receiving fresh domestic sewage, will not produce objectionable odors perceptible more than a hundred feet or so from the plant. But these conditions are found in few plants; and even in those where they obtain most of the time, odors occasionally occur due to unforeseen and frequently undiscoverable temporary conditions. At plants where or during times when odors are created by the chemical or biochemical processes therein, it is desirable to have available some method of modifying or supplementing the operation which will prevent the creation or dissemination of such odors. The result of Macon's investigation of one such method is described in this article.

The table giving the data secured is in considerably more detail than tables ordinarily submitted with articles of this type; but the authors say that they believe that "for an investigation of this type to be of any value at all, it is necessary to include as completely as possible all data pertaining thereto."

For several years the City of Macon, Missouri, has had difficulty in operating its sewage treatment plant without numerous complaints of obnoxious odors from the residents living in the vicinity of the plant. In the summer of 1928 certain structural features of the Imhoff tank were corrected on the recommendation of the State Board of Health, and better supervision and operation given the plant by the city authorities, which resulted in less trouble from odors. However, despite these changes in design and reasonably good operation, some trouble was still experienced. To determine whether odor at this plant could be controlled economically by chlorination, investigations with the use of this chemical were undertaken by the State Board of Health.

DESCRIPTION OF PLANT

Macon is a city of about thirty-five hundred population which is served by a combined sanitary and storm system of sewers. Treatment is secured by means of a plant consisting of coarse bar screen, Imhoff tank, sludge drying bed and sprinkling filter. The sewage flows by gravity through the Imhoff tank to a sump, from which it is pumped into the dosing tank by two float-controlled, electrically operated centrifugal pumps. After passing through the sprinkling filters the effluent is discharged into a wet-weather creek.

Unfortunately, the treatment plant is located in close proximity to a residential district, several houses being within six hundred feet of the plant in the direction toward which the prevailing winds blow during the summer months. On the eighteen-inch outfall sewer, six hundred feet ahead of the Imhoff tank, is located a diverting manhole provided with a float-regulated hydraulic valve for bypassing the sewage directly into the creek when storm water increases the flow in excess of the treatment plant capacity.

As originally designed, the baffles at the influent and effluent ends of the Imhoff tank extended 18 inches below the water level in the tank. This tended to divert the flow of fresh sewage along the bottom of the settling chamber, where septic sewage which had a high hydrogen sulphide content was encountered. As a result, the effluent sewage contained a mixture of septic and fresh sewage which added materially to the odors produced. Also, the influent pipes to each settling chamber of the Imhoff tank, besides being placed at an angle to the longitudinal axis of the tank, were extended several inches through the end wall.

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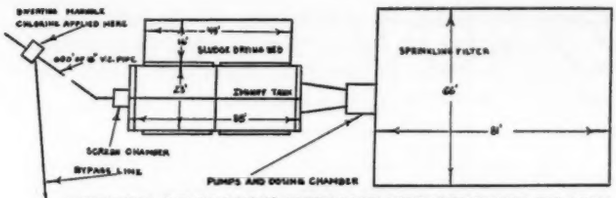
(2) Asst. Public Health Engineer, State Board of Health of Missouri.



SKETCH OF MACON SEWAGE TREATMENT PLANT

This arrangement created uneven flow across the width of the settling chamber, and a tendency to short circuit along one side. In 1928 the baffle walls were cut off to reduce the submergence to approximately three inches, and the influent pipes were cut off flush with the inside surface of the end wall. These changes produced considerable improvement in the operation of the Imhoff tank and less difficulty from odors was experienced; however, complaints continued.

PROCEDURE OF INVESTIGATION

For the purpose of experimenting with chlorination as a means of odor control, it was deemed desirable to know the rate of flow and also the total flow. To secure these data, a Veeder counter was connected to the dosing chamber by means of a float. From the known capacity of the dosing chamber and the number of discharges, the rate of flow was computed after suitable corrections had been made for the flow into the tank during the discharge period.* Observations of the counter reading were made each hour during the day and several times during the night, as shown by the table.

For the purpose of this investigation, the diverting manhole on the 18-inch outfall sewer was selected as the point to apply chlorine by means of a solution-type chlorinator furnished by the courtesy of Wallace and Tiernan Company. Various quantities of chlorine were added to the raw sewage. Routine hydrogen sulphide determinations were made, and an attempt to correlate the intensity of odors around the plant with the hydrogen sulphide content of sewage applied to the sprinkling filters. The differential method was used in making the hydrogen sulphide determinations. This method measures the volatile hydrogen sulphide, but is not accurate for hydrogen sulphide content of less than one part per million. Residual chlorine determinations were made by the ortho-tolidin method on samples collected at the diverting manhole and at the influent and effluent of the Imhoff tank.

RESULTS

The observations made during this investigation are indicated completely in the table. The air temperature conditions during the time covered by this work were very favorable to the production of hydrogen sulphide, the daily temperature varying from 80° to 83° F. at 8 A.M., and from 94° to 98° F. at 3 P.M. The sewage flow averaged approximately 225,000 gallons per day, representing dry-weather conditions. It will be noted that on the final day of the test, chlorine was fed at the rate of twenty pounds per day from 3 P. M. until 10 P. M. and at the rate of ten pounds

* This is the method suggested in Engineering Bulletin No. 16, University of Kansas, by J. L. Barron and R. E. Lawrence.

DATA ON ODOR CONTROL BY CHLORINATION AT MACON, MISSOURI

Date	Time	Rate of Flow (Gal. per day)	Chlorine (Lbs. per day)	Chlorine (P.p.m.)	Residual Chlorine (Diverting Manhole)	Residual Chlorine Influent Tank)	Hydrogen Sulphide p.p.m. Raw	Hydrogen Sulphide p.p.m. Influent	Hydrogen Sulphide p.p.m. Effluent	Odor (at sprinkling filters)	Odor (400 ft. distance from sprinkling filter)
July 30	3 p.m.	250,000	0.0	0.0	0.0	0.0	2.01	2.44	3.89	Strong	Fairly strong
	5 p.m.	243,000	0.0	0.0	0.0	0.0	2.20	2.39	3.71	Strong	Fairly strong
July 31	10 a.m.	304,000	23.0	9.1	0.10	0.0	1.74	0.81	2.02	Fairly strong	Fairly strong
	11 a.m.	304,000	23.0	9.1	0.20	0.0	1.81	0.64	1.79	Fairly strong	Fairly strong
	12 noon	304,000	23.0	9.1	0.20	0.0	1.65	0.50	1.60	Faint	None
	2 p.m.	243,000	23.0	11.4	0.70	0.30	1.71	0.00	0.51	Very faint	None
	3 p.m.	243,000	23.0	11.4	0.60	0.30	1.65	0.00	0.66	Very faint	Trace
	4 p.m.	243,000	23.0	11.4	0.50	0.10	1.98	0.00	0.75	Very faint	None
	5 p.m.	304,000	23.0	9.1	0.50	0.10	1.95	0.00	0.72	Very faint	None
	6 p.m.	304,000	23.0	9.1	0.50	Trace	1.90	0.00	0.60	Very faint	None
6 p.m.	-10 p.m.	220,000	18.0	9.9	0.40	Trace	....	....	....	Very faint	None
10 p.m.	-8 a.m.	183,000	14.0	9.2	0.30	....	....	....	....	Very faint	None
Aug. 1	8 a.m.	304.000	18.0	7.1	0.40	0.00	1.85	0.21	0.65	Very faint	Trace
	9 a.m.	304,000	18.0	7.1	0.40	0.00	1.99	0.15	1.00	Very faint	None
	10 a.m.	304,000	18.0	7.1	0.40	Trace	1.66	0.00	1.16	Very faint	None
	11 a.m.	273,000	18.0	7.9	0.40	Trace	1.91	0.00	1.23	Very faint	None
	12 noon	273,000	18.0	7.9	0.40	0.00	1.95	0.40	1.00	Very faint	Trace
	1 p.m.	260,000	22.0	10.2	0.70	0.20	1.80	0.00	0.68	Very faint	None
	2 p.m.	260,000	22.0	10.2	0.70	0.40	1.86	0.00	0.49	Very faint	None
	3 p.m.	273,000	22.0	9.7	0.30	0.00	1.70	0.00	1.10	Very faint	None
	4 p.m.	273,000	22.0	9.7	0.50	Trace	1.60	0.00	0.94	Very faint	None
	5 p.m.	243,000	22.0	10.9	0.60	0.10	....	....	....	Very faint	None
5 p.m.	-10 p.m.	243,000	20.0	9.8	....	....	....	....	....	Very faint	None
10 p.m.	-8 a.m.	186,000	10.0	6.5	....	....	....	....	....	Very faint	Trace
Aug. 2	8 a.m.	243,000	10.0	4.95	0.30	Trace	1.85	0.00	1.01	Very faint	Trace
	9 a.m.	243,000	10.0	4.95	0.30	0.00	1.79	0.32	1.22	Faint	None
	10 a.m.	304,000	10.0	3.94	0.20	0.00	1.87	0.29	1.43	Faint	None
	11 a.m.	304,000	10.0	3.94	0.20	0.00	1.91	0.24	1.63	Faint	Trace
	12 noon	304,000	10.0	3.94	0.20	0.00	1.91	0.24	1.63	Faint	Trace
	1 p.m.	243,000	10.0	4.95	0.30	0.00	1.92	0.25	1.57	Faint	None
	2 p.m.	243,000	10.0	4.95	0.30	0.00	1.87	0.31	1.40	Faint	None
	3 p.m.	304,000	20.0	7.92	0.40	0.00	1.76	0.10	1.20	Very faint	None
	4 p.m.	304,000	20.0	7.92	0.40	0.00	1.81	0.00	1.16	Very faint	None
	5 p.m.	304,000	20.0	7.92	0.30	Trace	1.94	0.00	0.99	Very faint	None
5 p.m.	-10 p.m.	221,000	20.0	10.9	....	....	....	....	....	Very faint	None

NOTE: At no time was there any residual chlorine in the Imhoff tank effluent.

per day for the remainder of the time. This corresponded to a dosage of from 7.92 p.p.m. to 10.9 p.p.m. from 3 P.M. to 10 P.M.; a dosage of 6.5 p.p.m. from 10 P.M. to 8 A.M.; and a dosage of from 3.94 p.p.m. to 4.95 p.p.m. from 8 A.M. to 3 P.M. This higher dosage, which was necessary in the afternoon and evening, seems to follow fairly closely previous observations at other plants. It is a well established fact that odors tend to be most obnoxious and travel further at this time of the day. A chlorine dosage of 3.94 p.p.m. to 10.9 p.p.m., depending on the time of day, represents the probable maximum required at this plant under most unfavorable conditions. Such a dosage would require thirteen pounds of chlorine per day which, at 8 cents per pound, amounts to $1.04 per day, or $4.65 per million gallons of sewage treated. No attempt was made to take advantage of wind conditions which blew the odor away from the residences, and hydrogen sulphide content was often kept lower than necessary to prevent trouble from migratory odors. Consequently $4.65 per million gallons is a maximum cost of chlorinating at Macon during most unfavorable circumstances, and is considerably in excess of the average cost over a longer period of time.

It is difficult to prophesy how many months of the year chlorination will be necessary, but probably chlorine treatment will not be required more than four months in the year. During these four months obviously there will be many days when the chlorine dosage can be reduced or stopped entirely because of rains, cool weather or winds which blow the odors away from the residential district.

No data are available on the chlorine dosage necessary to produce a residual at the Imhoff tank effluent, since this was not found necessary for the purpose of preventing odors. Excellent results were obtained during the critical period of the day by maintaining a slight residual chlorine in the sewage entering the Imhoff tank. Except during certain periods of the day, it was not found necessary to maintain a residual even in the tank influent.

The point which was selected for applying the chlorine seemed to be a favorable location. By applying chlorine at the diverting manhole, the hydrogen sulphide content of the Imhoff tank influent was maintained quite low. Since two parts of chlorine are required to remove one part of hydrogen sulphide, it is better to prevent its formation than to remove it after formation. During the detention period in the Imhoff tank, reasonable increase in hydrogen sulphide content is noted. From the results at Macon, it seems apparent that confining the volatile hydrogen sulphide content in the Imhoff tank effluent to a maximum of 1.5 p.p.m. will assure freedom from objectionable odors at all times.

An estimate of the cost of chlorinating at Macon, at the maximum dosage required, every day for four months, is given herewith. As indicated elsewhere, such maximum conditions are not probable.

Chlorinator and house	$1,200	
Cost of chlorine, $1.04 per day	$124.80	per year
Interest and depreciation (15% of $1,200)	180.00	" "
Water for operation	18.00	" "
No additional labor charge	.....	
	$322.80	" "

This maximum cost of $322.80 per year amounts to 6 per cent on $5,360. Obviously, the installation of a different type of secondary treatment, or abandonment of the plant, to eliminate odors would cost considerably in excess of this amount.

SUMMARY

Odor control by chlorination is effective and is the most economical known remedy of preventing odors at the Macon sewage treatment plant. Good operation will reduce considerably the amount and cost of chlorine required. The application of chlorine at the diversion manhole is successful and desirable, since the formation of hydrogen sulphide should be prevented as far as practicable because two parts of chlorine are required to remove one part of hydrogen sulphide. The dosage of 3.94 p.p.m to 10.9 p.p.m., depending on the time of day, will probably, under most adverse conditions, reduce the intensity of odors to an unobjectionable point.

As a control procedure to prevent the production of objectionable odors from the sprinkling filters, a maximum of 1.5 p.p.m. of volatile hydrogen sulphide in the Imhoff tank effluent should not be exceeded.

Sewage Treatment at Worcester

The report for last year of Andrew B. Holmstrom, superintendent of the Sewer Department of Worcester, Mass., relative to the operation of the treatment plant states that "The operation of the plant has been very successful during 1928. The smaller quantity of industrial wastes may be a greater factor in this result than would at first be appreciated. Tests of Sunday samples collected throughout the plant have demonstrated the ability of the plant to give a better effluent from the sewage of that day than from that of the usual week day."

The final effluent was perfectly stable after April 20th. The biochemical oxygen demand of the effluent averaged 18.8 parts per million, a reduction of 87.8 per cent.

The cost of maintenance and operation of the plant was $4.71 per million gallons of sewage treated based on payroll charges only, and $6.56 including all materials and supplies, teaming and department transfers of labor.

It was necessary to do some squeegeeing of the slopes of the Imhoff tank sedimentation compartments, and freeing of slots. Rags were found to hold deposits here; also to bunch at the bottom of the sludge pipes, causing trouble in drawing sludge from the tanks. "It is possible that finer screening of sewage may be necessary."

No scum has been removed from the gas vents since the plant was placed in operation in June, 1925. The average depth of scum runs 6 to 6½ feet, with a maximum of 8 feet. The grease removed from the surface of sewage in the sedimentation compartments averaged 25.3 cubic feet per day or 1.11 cubic feet per million gallons.

The sludge production averaged 2,085 gallons per million gallons of sewage, of which the dry solids content was 6.21 per cent.

The cost of removing dried sludge from the sludge beds was 52 cents a cubic yard plus the small expenditure for oil, grease and minor repairs of the Barber-Greene loader; which includes one month of an extremely long haul.

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Qualifications of Meter Readers

Meter readers for water, gas and other public utility departments and companies come into more frequent and intimate contact with a greater percentage of the consumers than any other class of employee or official, and the consumer is apt to base his attitude toward the company or department largely upon his feeling with respect to the meter reader. If the latter is surly or inclined to insist upon his "rights" to enter the premises at any time, the unpleasant relations so created will be passed on to the company or department. Large retail stores impress upon their clerks that "the customer is always right," and that, in telephoning, "the voice with the smile wins." The same general attitude on the part of meter readers should be insisted upon by superintendents.

One of the trials of meter readers is referred to elsewhere in this issue—the dog, whether watch, police, lap, yap or what have you. Some men can instantly make friends with nine dogs out of ten, possessing some personal quality which dogs at once recognize. They understand that in most cases a dog barks because, for a city dog, barking is almost the only interest life offers him besides eating and sleeping. But most men have the feeling of the one in the anecdote who, when told "Don't be afraid of the dog; you know, barking dogs don't bite;" replied. "Sure, I know a barking dog don't bite, and you know it; but does the dog know it?"

The ability to create and retain friendly relations with the consumers (without being too friendly with their servants) is perhaps as important a qualification in a meter reader as accuracy, industry and honesty. Ability to make friends with dogs is, of course, not so important; but while not every man with the former ability possesses the latter also, we think it very probable that those who irritate the humans in a house will not be on friendly relations with the canine occupants, either.

Hauling on the Sub-Grade

One of the points brought out by several speakers on the subject of pavement subgrades at the twenty-third annual meeting of the National Paving Brick Manufacturers' Association was the effect of non-uniform supporting power of the subgrade in causing cracks in concrete and other rigid-type pavements. One instance was cited where a pavement had cracked over the place where the wheels of a concrete mixer had rolled along the subgrade. Not only does hauling aggregate or other material over a finished subgrade necessitate redressing it before laying the concrete, but even this redressing does not remedy the unequal density and therefore non-uniformity of its supporting power, caused by the hauling of heavy loads over it.

This would seem to be a very important matter in the construction of concrete pavements or concrete foundations, and one which it often is difficult to avoid. Where the paved surface occupies practically the entire width of the roadway, it seems to be im-

practicable to prevent hauling of the aggregate over the finished subgrade, especially where this is on either cut or fill; also where the roadway is only wide enough for two traffic lanes, and one of them must be kept open for traffic during construction. If, as is usually the case in concrete highway construction, the subgrade is finished a thousand feet or more ahead of the concreting gang, protecting the subgrade would necessitate maintaining that length of plank-covered road or some substitute therefor. An alternative would be to require all of the vehicles travelling over the finished subgrade to so vary their course over it in successive trips as to ultimately cover the entire surface thereof, rather than following in ruts or tracks. This would possibly be difficult but by no means impossible; for instance, poles or other standards might be set at 50 or 100-foot intervals along the subgrade and a man in charge of the traffic could shift these a few inches from time to time so as to gradually work the wheel lines across the road from one side to the other.

Some contractors reduce the rutting of the subgrade by using pneumatic tires on the trucks; but this would but slightly remedy the non-uniformity of support offered by the subgrade.

The matter seems to be an important one, especially in clay or loam soils subject to considerable compacting under traffic.

Road Materials and Manufacturers' Associations

"Nearly all of the companies engaged in the manufacture and sale of highway equipment, materials and supplies have formed themselves into specialized groups or associations and have founded laboratories where tests are conducted with a view to improving their products. They are very liberal in sending out lecturers and in having the results of their experiments published and circulated so that the knowledge gained benefits not only their trade but also the engineers who are to design and build pavements and structures. I would, therefore, call to your attention, as one of the great features of this industry, the important laboratory and educational work which is being done by such organizations as the Portland Cement Association, the Asphalt Association, the Rock Products Association, the American Concrete Institute, the Gravel Products Association, the Pipe and Tile Manufacturers, the makers of metal reinforcing materials, and many other groups, all of which is of such assistance to engineers and contractors. (The author omitted, probably through inadvertence, the National Paving Brick Manufacturers Association.) These organizations and others, such as the equipment makers and the powder manufacturers, employ some of the best technical minds in this country and I have found that they always stand ready and willing to lend us a helping hand whenever it is needed. I think it is right and proper that we should make some acknowledgment of thanks for the service they at all times render so gladly. At any rate, I for one appreciate the work they are doing for the advancement of the highway industry."

The above is quoted from an address before the New York State Highway Chapter of the Associated General Contractors of America, by Charles R. Waters, district engineer of the New York State Department of Public Works. Mr. Waters speaks frankly concerning a matter which probably has raised doubt in the minds of many engineers as to just what their attitude should be toward these associations.

It seems to us that there cannot be much question as to the proper attitude of engineers toward the information and activity emanating from them. The high-grade engineers and scientists working for these associations have, as one of their purposes, and probably the leading one, that of discovering the methods of using their materials which will generally produce the best results. This also is the aim of the engineer who uses such materials, and his interests are therefore identical with those of the material associations in this respect. Thus, having decided to use concrete, asphalt, or other material in a pavement, he should have no hesitancy in accepting and adopting the advice of the association commercially interested in such material. They are not infallible and may, of course, be mistaken in some cases; but to make a mistake along this line is against their own interest, since it will injuriously affect future sale of the material; and the probability that they would make such mistakes is much less than that the engineer himself, with his much more limited opportunities for investigation and knowledge of the subject, would do so.

There is another purpose of the investigations of these organizations, having to do with increasing and broadening the field in which their respective materials can be used. Investigations and conclusions therefrom having to do with this branch of activity must be subjected to the critical examination of the engineer in the same way as other arguments for or against the use of competitive materials. Probably most of the scientists working upon these investigations are themselves convinced that their materials can be used, perhaps more satisfactorily than any other material, for the purpose indicated; and yet their natural prejudice may lead them into exaggeration if not actual misconception and misstatement. But is not the same true of engineers themselves? In any large group of engineers, each of them entirely uninfluenced by any commercial consideration, we will find wide differences of opinion as to the excellence of competing materials. Some will claim that concrete pavement is the best for almost any location, while others will claim the same merits for asphalt, others for brick, etc. Some will claim that a 2-inch brick pavement is just as good as a 4-inch, with the added advantage of cheapness; while another firmly believes that a 2-inch pavement will not stand up under the traffic which it would have to carry on his roads and streets. In the majority of cases, the opinion entertained by an engineer is probably the result of his personal experiences, such as the local conditions as to soil, topography, etc., under which the highways in his district are laid and used.

In selecting the material for his pavements, for his water mains, or whatever work he has in contemplation, the engineer must use his best judgment in comparing the relative advantages and disadvantages of the available materials as represented to him by his brother engineers and by the manufacturers' associations; endeavoring to allow in each case for probable prejudices and to ascertain the facts and base his conclusions upon them alone. In general he can be as sure, and even more sure, of the *facts* as presented

by the scientists employed by the associations than of those presented by unprejudiced engineers; since the latter, out of their limited knowledge, are more apt to unconsciously misrepresent the facts than are the much better informed scientists, even though their commercial attachments may cause them to be prejudiced.

But having made his selection of the material to be used, the engineer can then with confidence accept not only the scientific facts but also the advice of these associations as to the most satisfactory method of using it; for the associations are wise enough to realize that future use of their materials is dependent upon satisfaction given by the use of them in work now being carried on.

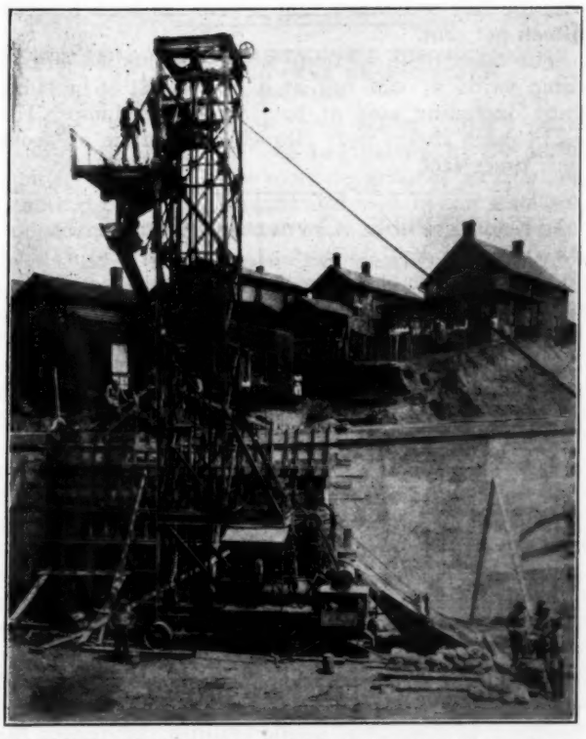
Bergen County Highways

Through an oversight we failed to give credit to the Ingersoll-Rand Co. for illustrations used in connection with the article published under the above title in the September issue. The photographs, except as otherwise indicated, were furnished through the courtesy of that company.

Portable Tower for Building Concrete Wall

A concrete retaining wall has been built at Youngstown, Ohio, in a railroad cut, in the construction of which the contractor, the H. E. Culbertson Co., of Cleveland, used a rather unusual piece of equipment—a portable concreting tower.

The wall was of steel reinforced concrete, 35 feet high, 15 feet 3 inches thick at the base and 2 feet 6 inches at the top, 1400 feet long. There was very little space in which to work, and that along the bottom of the wall, and no space for storing materials.



COMBINED TOWER AND MIXER USED IN CONSTRUCTING RETAINING WALL

The seven thousand cubic yards had to be placed in minimum time—it was actually done in two months.

The contractor used a standard Smith paver with the boom and bucket removed and instead a 52-foot steel tower mounted in front of the mixer, carrying chutes for distributing the concrete, which was emptied into a receiving hopper by an elevating bucket—the standard type of equipment for stationary towers. The entire unit of mixer and tower moved along the foot of the wall as the filling of the forms progressed. The height of the tower permitted the use of steep chutes, and the mix was made much drier than is customary for such work.

Discharge of Sewage Into Sea Water

Conditions along Pacific coast materially different from those along the Atlantic. Effect of salinity on diffusion phenomena

Predetermination of the area and extent which will probably be attained by a sewage field when a sewer discharges into sea water, and the relation thereto of the quantity of sewage discharged and the direction and depth of discharge, was the aim of a series of experiments undertaken by A. M. Rawn and H. K. Palmer, assistant chief engineer and chief draftsman, respectively, of the Los Angeles County Sanitation District; which were described by them in a paper printed in the May, 1929, *Proceedings* of the American Society of Civil Egineers. The experiments were made in connection with studies for an ocean outfall contemplated by the Los Angeles County Sanitary Districts. From their experiments the authors derived formulas for the area of a sewage field, its diameter, etc., as functions of the diameter of outlet, depth below the surface, number of outlets, quantity of sewage, velocity of ocean current, velocity of sewage leaving outlet, etc. The paper consists so largely of involved and inter-related formulas and diagrams that an abstract of it seems to be impracticable.

Discussions of the paper in the September *Proceedings* by several engineers contain a number of interesting facts and ideas relative to the subject. R. F. Goudey, Resident Engineer California State Department of Public Health, stated that conditions relative to sewage discharge into the Pacific differed materially from those obtaining on the Atlantic Coast. Instead of a Gulf Stream, with good currents relatively close to shore, "California's main current, the Japan current, runs more than 1000 miles from shore. The littoral currents are wind-induced, low in velocity, variable in direction, and undependable for sewage disposal. The wind direction, likewise, is variable, due to changing from land to ocean breezes daily. For instance, during the night the land breezes prevail from north to east, and, finally, work around to the southeast in the early morning. With the overcoming of the land breezes by the ocean winds during the forenoon, the prevailing and strongest winds of the day come from the southwest. Toward evening, they veer toward the north, when the land breezes dominate. Except dur-

ing stormy periods, when the winds are either from the north or southeast, this continual routine of 'boxing the compass' accounts for the lack of uniformity in dependable shore currents."

This difference in conditions might well affect the applicability to outlets into the Atlantic Coast of conclusions based entirely upon studies of outlets into the Pacific; although the authors endeavored to allow for all variables in deriving their formulas.

In his discussion of the paper, Kenneth Allen, Sanitary Engineer, Board of Estimate and Apportioment, New York City, described a number of experiments conducted in the waters of New York harbor, in laboratories and a tank in the Aquarium, concluding with the following statements:

"It is clear that salinity of a body of water receiving sewage is an important factor in its diffusion, as it also is in its oxidation, its effect on precipitation, its decomposition, its general appearance, and its accompanying odors. The sewage of the City of Washington, D. C., discharged in 30 feet of fresh water in the Potomac river and that of Hamburg, Germany, discharged at a depth of 30 feet in the Elbe, is difficult to discern at the surface, while that from the Boston and New York outlets forms a field on the surface that is often clearly visible, well defined, and extensive. It was noted in the New York experiments with dyes that the edge of the field on the windward side was most clearly defined, while the more rapid diffusion took place on the leeward side.

"From what has been said it is evident that diffusion is promoted by locating inlets in deep water of low salinity, but having a high velocity of flow. Discharge should be horizontal and from multiple outlets. The submerged outlets from Deer Island in Boston Harbor, with fourteen horizontal orifices, and the one hundred and fifty outlets of the Passaic Valley Sewer, in which the upward-flowing stream is dissipated by spiral flanges, are excellent examples of effective diffusion and dilution of an effluent in salt water.

"As the visibility of sewage fields in calm weather is largely due to the oily surface film known as 'sleek,' it is obvious that for the sake of appearance, oily wastes should be kept out of effluents so far as practicable: First, by control and treatment at the source of industrial wastes of this nature; second, by providing municipal collection of crank-case waste from garages; and, third, by installing skimming tanks on the line of outfall sewers. Other points that might be emphasized are the very great effect of turbulence of current on diffusion, and the variable effect of winds on the shape and extent of the sewage field."

Setting Poles in Swampy Ground

In constructing a transmission line along the shore of Lake Michigan, the Gary Heat, Light & Power Co. had to cross two and a half miles of sand fill over swamp muck and quicksand with its poles. For this work, southern pine poles were used, treated by an empty-cell process with a retention of 8 pounds of creosote; the poles being gained and bored before treatment. They ranged in length from 45 feet to 65 feet, with 10-inch tips and butts averaging 16 inches.

Digging holes and setting them in the customary way in the ground described would have been difficult. Instead, dynamite was used as follows: An iron pipe fitted with a removable wooden tip was driven into the ground to the depth it was desired to set the pole, and in this pipe was inserted from one to two sticks of quick-acting dynamite. The pipe was then removed, the dynamite charge being kept at the bottom of the hole by a rod inserted inside the pipe. The pole was then set in a vertical position directly above the charge and held by guys. The dynamite was then exploded, which blew out the ground under the pole, and the pole dropped into the hole so made and to the desired depth. The hole around the pole was filled with earth and thoroughly tamped.

Machinery in Worcester's Sewer Construction

The Sewer Department of Worcester, Mass., according to the superintendent, Andrew B. Holmstrom, in 1928 built 13.2 miles of sewers, of sizes up to 72 inches diameter and at depths reaching 20 feet, including all necessary catch basins. An average of 302 men were employed from April 1 to December 1, while during the other four months the average was 245.

Every effort was made to secure tight sewers, and Weston forms were used to enable the men to obtain tighter joints.

Said Mr. Holmstrom: "All our machinery has been modernized. At the present time we have one 1-yard P&H shovel, two 'Speeder' shovels and one Type A Erie shovel. We also have three backfillers, two of them Fordsons and one P&H. Pneumatic spades and pavement breakers have been purchased, with the necessary compressors. At the present time we have five compressors. We have also adopted modern cost-keeping and control methods. These factors have enabled us to speed up the work tremendously and also helped us to do the work more efficiently. We find that the cost of constructing sewers has been reduced fifteen per cent."

The catch basin cleaning machines handled 11,676 cubic yards of material at a cost of $1.66 a cubic yard, including cost of hauling to the dump. The 4,714 catch basins were cleaned an average of about four times each.

Kansas Public Ownership Conference

A "Public Ownership Conference" is to be held at Arkansas City on October 28, for officials representing cities and towns of Kansas that own and operate public utility properties such as electricity, water and gas. The purpose is to effect a permanent organization of an association the object of which is: (1) To protect and safeguard the rights of municipal public utilities through education of the public and promotion of adequate laws through our legislators; (2) To promote greater efficiency in plant operation through standardizing and systematizing plants and operating systems by the exchange of ideas, information and experiences and personal assistance whenever necessary or possible; (3) To establish a publicity bureau through which news of importance can be disseminated to the membership; (4) To promote good-will, friendship, and co-operation through association and acquaintance; and (5) To foster and promote the upbuilding of municipal public utilities throughout the State of Kansas.

Recent Legal Decisions

CITY COUNCIL'S DISCRETION IN RELOCATION AND EXTENSION OF STREETS

The Ohio Court of Appeals holds, Koch v. City of Toledo, 30 Ohio App. 68, 164 N. E. 124, that a city council, in determining whether or not it will proceed with the relocation and extension of a street, may consider all conditions and all elements; not only the needs of traffic, and its hazards, but also the industrial growth and development and welfare of the city. Where there is room for great difference of opinion as to the best course to pursue, the court cannot interfere with the legislative action of the council.

FUTURE NEEDS OF TRAFFIC MAY BE CONSIDERED IN FIXING WIDTH OF NEW STREET

The Illinois Supreme Court says, City of Jacksonville v. Dorwart, 333 Ill. 143, 164 N. E. 129, sustaining a city ordinance providing for the opening of a street adjoining an athletic field to a width of 100 feet: "In determining whether an improvement ordinance is reasonable or unreasonable, the court must take into consideration the object to be accomplished, the means for its accomplishment, and all existing conditions and circumstances. The streets of cities at this day are required to do a greater service than merely affording passageway from one point to another. The right of the public to stop at a given point and to make use of the street in large numbers in a manner inconsistent with the needs of traffic and subject to existing reasonable traffic regulations must be conceded, and the city council has a right, in laying out streets, to determine, in so far as it can, the reasonable future needs of the traffic at a given point."

STATE ROAD DEPARTMENT'S DISCRETION IN SELECTING LOWEST RESPONSIBLE BIDDER

The Florida Supreme Court holds, Willis v. Hathaway, 117 So. 89, that the Legislature, by the statute under which the state road department awards road contracts, intended to and did vest in the state road department the power, authority and duty to determine not only from a standpoint of dollars and cents who should appear to be the lowest bidder, but also to determine from information available to and acquired by the state road department what bidder or bidders would be adjudged by the department to be responsible bidders for each particular contract sought to be awarded and to determine the lowest of such responsible bidders, and in determining the responsibility of the bidder it became the duty of the road department to ascertain the degree of experience, the reputation for performance, the possession of facilities, the outstanding obligations, the obligations then assumed or about to be assumed, the integrity and credit, as well as other matters which might touch and have influence upon the ability of each bidder to perform the contract for which he had placed a bid. The statute vested in the road department the discretion to determine responsible bidders, and it was held, in a suit to enjoin the performance of a hard-surface road contract in Levy County, that the complainants had not met the burden of showing that the discretion was exercised on a misconception of law or in ignorance, through lack of inquiry, or was the result of arbitrary will or improper influence or in violation of law.

LIABILITY OF DEFECTIVE CONTRACT BRIDGES OR CAUSEWAYS UNDER ALABAMA STATUTE

The Alabama Supreme Court holds, Barbour County v. Reeves, 116 So. 119, that the Alabama statute (section 6457 of the Code) providing that if no guaranty of the safety of a contract bridge has been taken by the county, or the period of the guaranty taken has expired, any person injured by a defect in the bridge may sue and recover damages of the county, means that the county is liable, during the life of a contract bridge, if no guaranty has been taken or the period covered by the guaranty has expired. It does not mean that if a county enters into a contract for the construction of a public bridge it thereby becomes liable in perpetuity for defects in any bridge that may thereafter be erected by the county at the same place, so long at least as successive bridges may serve as constituent parts of the highway at the same place.

To make a county liable for damages caused by a defect in a bridge or causeway under Alabama Code, section 6457, the bridge or causeway must have been constructed by an independent contractor under a contract made with the county through its governing body. Evidence that a county bridge was built under the supervision of county commissioners or one of them by a mere employee of the county who was paid for his labor was held insufficient to show that the bridge was built by an independent contractor. Marshall County v. Cleveland, Alabama Supreme Court, 117 So. 621.

WHERE PROCEDURE AS TO STREET PAVING NOT PRESCRIBED BY CITY CHARTER

The Oklahoma Supreme Court holds, Bacon v. Wimma, 267 Pac. 261, that where a city charter contains no provisions relating to street paving, the general paving law of the state governs. Where the charter provides no procedure relative to street paving, and the general paving law of the state requires no resolution awarding paving contracts and approving bonds, the approval of the mayor to a paving contract entered into by the city is not required; the provision of the city charter requiring all resolutions passed by the council to be presented to the mayor for his approval and signature having reference only to such resolutions as are contemplated by charter provisions or statutory enactment not in conflict with the charter.

COUNTY COMMISSIONERS' DISCRETION TO USE DIFFERENT KINDS OF HARD SURFACING

The Oklahoma Supreme Court holds, Allen v. Board of Com's of Logan County, 267 Pac. 860, that a board of county commissioners is not authorized to expend the proceeds of road bonds on a portion of the roads designated in the resolution calling the bond election to the exclusion of other roads designated. But the board has a discretion to determine the kind of hard surfacing of the different roads or portions of roads

so long as the improvement comes within the statutory designation of hard surface contained in Okla. Laws 1923-24, c. 48, § 16, defining "hard surface" to mean a road surfaced with concrete, brick, water bound, or bituminous macadam or the equivalent of properly bound gravel or other material to be approved by the state highway commission and meeting the Federal requirements.

PRIORITY OF CLAIMS OF MATERIALMEN AND ASSIGNEE OF CONTRACTOR—TIME OF COMPLETION OF ROAD WORK

The Kansas Supreme Court holds, Citizens' First Nat. Bank v. Board of Com's of Jefferson County, 267 Pac. 12, that one who furnishes material and performs labor in the construction of a road at the request of the contractor is entitled to the payment of his claim, if presented within time, out of the funds still in the hands of the county belonging to the contractor, in preference to the assignee of the contractor. The assignee has no greater right to the funds in the hands of the county due the contractor than the contractor himself would have as against valid unpaid claims for labor and materials used in construction of the road, when presented within time.

As between assignments by the contractor to two different parties, of funds in the hands of the county belonging to the contractor, there is a preference or priority of right in favor of the one showing the funds loaned or advanced to have been used in the actual construction of the road.

The test as to the time when a piece of work is completed, under Kansas R. S. 60-1414, in order to preserve a lien, is determined by the fact of whether the unfinished work, in this case the repainting of the guard rails, was a part of the original contract, necessary to be done to complete the job, and comply in good faith with the requirements of the contract.

ADJUSTMENT OF DIFFERENCES UNDER CONTRACT FOR ERECTION OF SCHOOL BUILDING

The New Jersey Supreme Court holds, Shaner & Sons v. Board of Education of Millville, 142 Atl. 425, that the New Jersey School Law makes the board of education in a city school district a corporation empowered to enter into contracts for the erection of schools, etc., and that matters growing out of such contracts are within the sole control of the board, and a municipal corporation has no standing to interfere with such action as the board may propose to take in the matter of adjusting differences between the board and contractor under a contract for the erection of a school building. The mere fact that the principal and interest of bonds issued for school purposes has to be met by the city was held to be immaterial in this respect.

INCREASE OF BURDEN AS TAXPAYER UNDER STATUTE TO SUE FOR INJUNCTION OF CONTRACT

The Kansas Supreme Court holds, Home Riverside Coal Mines Co. v. McAuliffe, 267 Pac. 996, that, under Kansas R. S. 60-1121, an individual taxpayer cannot maintain an action to enjoin public officials from entering into a contract alleged to be unauthorized unless his burdens as a taxpayer may be increased by the threatened unauthorized contract. The petition was held to lack any allegation of fact from which this result would follow from the contract, which was with an electric power company for electric energy to be used in pumping water for the municipality's water plant.

PROPERTY OWNER BARRED BY DELAY FROM CONTESTING IMPROVEMENT PROCEEDINBS

The New Jersey Supreme Court holds, Pico v. Borough of North Arlington, 143 Atl. 861, that a property owner seeking by certiorari to review a paving ordinance, who made no objection to the assessment proceedings at the public hearing before the commissioners, and did not appeal to the circuit court to present his objections in accordance with the statute, but applied for certiorari more than five months after the confirmation of the assessment report, was barred by laches from contesting the proceedings.

GASOLINE, OIL AND GREASE USED IN OPERATING ROAD CONTRACTORS' TRUCKS AND MACHINERY LIENABLE UNDER ILLINOIS STATUTE

The Illinois Supreme Court, Standard Oil Co. v. Vanderboom, 326 Ill. 418, 158 N. E. 151, holds that gasoline, oil and grease sold and delivered to contractors constructing a road for the state, and used in operating trucks, concrete mixers and machinery, but which did not become a part of the completed improvement, are lienable under Section 23 of the state Mechanics' Lien Law, which gives the person who furnishes material, etc., to any contractor having a warrant for public improvement for the state a lien upon the money owing to the contractor by the state for the value of the materials. Here the contractors defaulted and did not complete the contract, which was completed by the surety.

SUFFICIENT ASSIGNMENT OF RETAINAGE BY ROAD CONTRACTOR

The Alabama Supreme Court holds, Bank of Luverne v. Alabama Bank & Trust Co., 117 So. 219, that an assignment of claim sent by a road construction company to the state highway department as follows: "Please pay the Bank of Luverne, Luverne, Ala., retainage which is now due or may become due us on Project 93-B, Monroe County," was, in equity, sufficient, as between the parties, to pass the right to funds held by the state highway department for road work done by the contractors.

IMPROPER DIVERSION OF PROCEEDS OF BOND ISSUE FROM SPECIFIED PURPOSE

The Georgia Supreme Court holds, City of Fayetteville v. Huddleston, 142 S. E. 280, that the municipal authorities of a city, in the absence of express legislative authority, have no power to use funds derived from the sale of an issue of bonds, issued by the city for a specific purpose, for another and different purpose. Where a city's charter provided that the proceeds of any authorized bond issue should only be applied for the purposes for which the bonds were issued, it was held that the trial court did not err in issuing a temporary injunction restraining the city from diverting funds derived from the sale of bonds authorized by a vote of the city's qualified voters for the specific purpose of installing a lighting system, and from using $7,500 of this fund in the completion of a system of waterworks, although the proposed diversion was authorized in a plebiscite by a two-thirds vote of the qualified voters.